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ABSTRACT

This guide provides information and activities descriptions designed to allow the teacher to use wildlife concepts in the teaching of various subjects. The author suggests that wildlife and animals are tremendous motivators for children and hold their attention. In the process, concepts of wildlife interaction with man and the environment are taught along with the major subject. The guide does not presuppose an extensive knowledge of science. In addition to activities and concepts tailored for a variety of classroom subjects, the guide provides a history of American wildlife, a presentation of basic concepts of wildlife education, and a bibliography of field guides, activities, life histories, and periodicals of interest to the classroom teacher seeking to use their technique. (RE)

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MULTIDISCIPLINARY WILDLIFE TEACHING ACTIVITIES

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and Environmental Education
The Ohio State University
School of Natural Resources
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ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for these publications are invited.

John F. Disinger
Associate Director
Environmental Education

Sponsored by the Educational Resources Information Center of the National Institute of Education and The Ohio State University.

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He has served on the Arizona Environmental Education Advisory Council, the Project Learning Tree Advisory Council, is a member of the Western Regional Environmental Education Council, and many conservation and professional organizations.

Bob has received awards as Arizona Conservationist of the Year in 1970 and in 1971; Conservation Educator of the Year, 1973; and The Wildlife Society's Conservation Education Award in 1978.

PREFACE

The format of this guide has been tested and evaluated by several hundred classroom teachers. Modifications were made upon their recommendations. The final format is one deemed "useable" by these teachers. A wildlife biologist or ecologist may, as "purist," find fault with details of concepts and understandings, with glossaries or bibliographies; but we must remember who the guide was written for--the classroom teacher. The materials are accurate, objective, and most important, useable.

The purpose of this guide is to supply the teacher with a tool with which to deal with the concepts and understandings of wildlife ecology and conservation--concepts and understandings that apply to the human environment as well.

Only an environmentally educated generation can eventually create a quality environment for wildlife...and for man.

INTRODUCTION

An open letter to teachers--

Dear Teacher:

Why should you be interested in wildlife? Our answer is that wildlife can open some of the most exciting doors to teaching that you have ever experienced. We know that your toughest job is motivation--wildlife is a motivator par excellence.

Thornton Burgess, that fine old gentleman who wrote of Peter Rabbit and Brer Fox, once said:

> "A universal interest in animals and birds is not confined to children. I question if there is another subject which can even approach animal life in universal appeal to young and old."

Thornton Burgess was right! You can use wildlife to spice up a lesson plan for art, English, social studies, science, or even industrial arts and home economics (try cooking game meat). Wildlife will guarantee the attention of children--when you have their attention, that becomes a teachable moment.

This guide was designed, of course, to teach concepts in wildlife ecology and conservation; but it was also designed as enrichment to existing curricula. Use it that way.

This activity guide will allow you to integrate wildlife ecology and conservation into the classroom subjects you already teach. You do not need a science background, or to be teaching science. Wildlife is all around you--not just in the science class. Your students are already interested in the animal world--why not use that interest to teach mathematics, social studies, language and fine arts? Wildlife can be the focal point for teaching in any curriculum area. And wildlife can be a wonderful magnet for any classroom learning center.

<u>It is not necessary to have nature centers and consultant help. This guide was written for the classroom teacher to use in the classroom, or on the campus, and off-campus when field trips are available</u>.

The guide deals with wildlife for three major reasons: First, because we believe there is no single subject of more interest to children than animals, and that this interest can be used to teach and to motivate--not only to the benefit of wildlife, but to the betterment of the total environment, and thereby, the well-being of man.

We also believe wildlife to be a readable barometer of environmental conditions--a thermometer charting the fevers of environmental sickness. We further recognize that whatever threatens wildlife, also threatens man.

And third, because we believe in the importance of man's interrelationships with wildlife and with the other elements of his natural environment. We believe the great wildlife resource should continue as fellow-traveler and inspiration to man.

There are only three simple steps to using this guide:

1. Look in the activity section. Find an activity which would enrich your lesson plan. Adapt and change it to fit YOUR needs.

Activities have been designated as primary, intermediate, upper elementary and high school, and are further classified as to curriculum area. There are activities for language arts, fine arts, social science, mathematics, science and vocational education. But these designations of grade level and curriculum have been entirely arbitrary--they are only for your convenience in getting started. Please use them as you see fit.

2. At the end of each activity description you will find a code, such as Concept #1B.

3. Turn back to the basic concepts, which start on page 7. Find concept number one and understanding B. Each concept is short, nontechnical and informative; each contains a basic principle of wildlife ecology or conservation.

Weave that concept or understanding into your lesson plan, in your own way, in your own words. In this way, you are teaching your mandated subject and adding the concept of wildlife ecology or wildlife conservation.

At your leisure you can read the introduction, "America's Wildlife--Past, Present and Future," and the other concepts and understandings. We think you will enjoy just reading these materials. You will also discover a vocabulary of words underlined in the text, and an outstanding bibliography of excellent books on American wildlife.

This is YOUR guide--Adapt, Innovate, Change.

We hope you will find the guide exciting, fun, and of tremendous help. That is its intent.

--The Author

P.S. We would like to express our appreciation to the Arizona Department of Education and Superintendent Carolyn Warner for use of materials developed for the Teachers Resource Guide for Environmental Education.

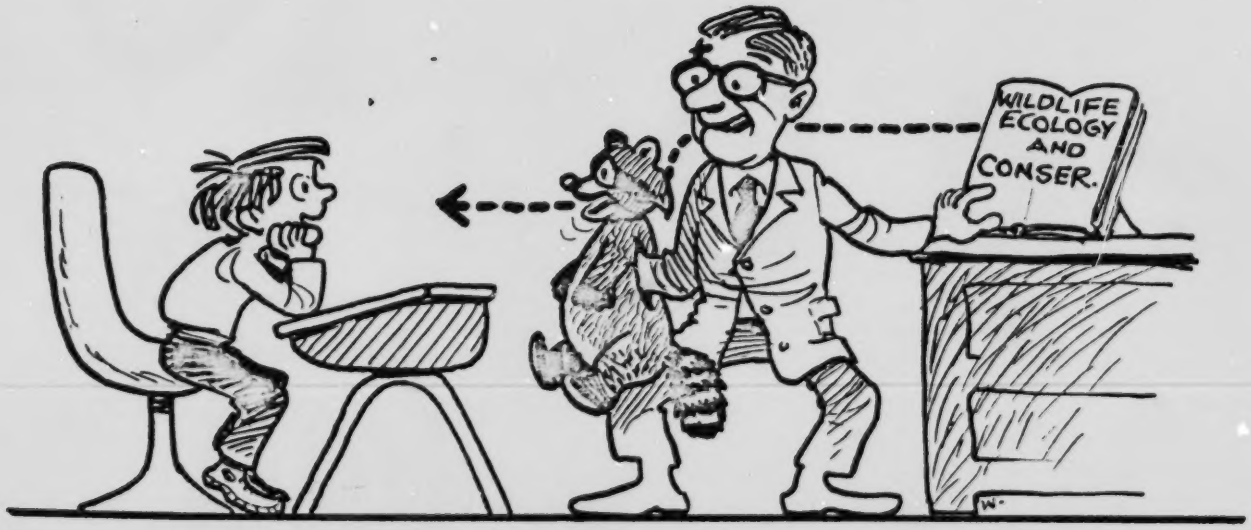
And to the American Forest Institute for permission to use and adapt activities from their Project Learning Tree teachers guides it would have been difficult to create material to match.

And a special, personal thanks to some special people--for a lot of things:

Dr. Thomas Kennedy
Miss June McSwain
Cheryl Charles
Carlos Moore

and about 1,000, neat, neat teachers who have helped in so many ways.

Finally a super-special thank you to Oscar (Ozz) Warbach, recently retired from the Michigan Department of Natural Resources, for some new perceptive illustrations and his permission to use art work created earlier.



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AMERICA'S WILDLIFE--PAST, PRESENT AND FUTURE

What is wildlife? How should we define this word? In this guide "wildlife" means birds, fish, insects, mammals, amphibians, reptiles, etc.--all living animals. All of these are a part of America's wildlife heritage--a treasure we must assure for all time.

America, with its splendid variety of landscape, is blessed with an unequaled variety of wildlife--each species carefully adapted to live only in a very specific environment or habitat.

Kaibab squirrels live only in the coniferous forests of the Kaibab Plateau in Arizona. The American alligator lives only in the swamplands of our southeastern states; whitetailed deer are resident in most states, while sea lions and sea otters inhabit the seashores.

Man is able to adapt and share the environments of all of these creatures--you and the wildlife of America share these many and varied environments.

For us to assure the continued presence of this great resource, we must know about wildlife and its environments or habitats; we must understand the interrelationships between species, between species and their environments, and the interrelationships between man and wildlife. And we must understand and practice the concept of conservation.

Wildlife conservation is the wise and careful use of a renewable resource. Conservation does not just mean "putting a fence around a resource and giving it total protection."

The harvest of lumber from a forest, or of forage from a grassland, shows us that such a harvest, properly controlled, does not damage a living, renewable resource. This concept also applies to wildlife, which is a living, renewable resource.

We know the values of wildlife to man--not just as food and fiber, but as pollinators of his domestic plants, as cleansers of his natural world, as sources of recreation, and as inspiration for his song and legend, art, literature and dance.

History also records conflict between man and wildlife--records damage to man's crops, of his hereditary fears of certain species and of wildlife occupying lands desired and needed by man to feed his ever-growing population. (How could America's farmers have lived with a hundred-million buffalo?)

Our knowledge of, our attitudes towards and our relationships with wildlife are many faceted. Our attitudes have been affected by history, by economics, religious and ethnic backgrounds, and today are being dramatically affected by a conflict between urban and rural understandings of our natural world.

There are many concepts and attitudes applying to wildlife, and perhaps as many questions. It becomes obvious that man has yet to fully understand his relationships with this natural world. But it is equally obvious that wildlife is, and has been, an essential and desirable part of our environment.

What was our America like when the European explorers and settlers came? What wildlife wonders did they see? Were the streams alive with fish and the hillsides covered with deer? Were there beaver in every riverbottom and bighorns on every crag? The answers to these questions may surprise you.

There were certainly more buffalo in America in 1600 than today--but wildlife biologists tell us there are probably more whitetailed deer in America today than then, and certainly more coyotes. Our history books tell us that Pilgrims nearly starved at times. This would suggest a scarcity of fish in the streams and of other wildlife in the coastal forests. There were beaver in the streams--the quest for beaver skins led trappers to explore most of the west, even such desert regions as Arizona.

Some species of birds were more common--others have multiplied in number as a result of man's activities, and still others, such as the sparrow and starling, were introduced by these settlers.

Lewis and Clark, and other explorers, recorded times when they had to eat their horses and mules because wildlife was so scarce.

The answers to our questions are both yes and no. Wildlife was plentiful and wildlife was scarce. The answer varies with the species and the location.

Today's thriving species are those which have adjusted to living with man. This <u>adaptation</u> was usually forced by man's changes of the land. When the change favored a species, that species prospered. When the changes did not favor a species, that species adapted or passed out of the picture.

The coyote, perhaps the most adaptable animal in America, prospered with man's changes of the landscape (in spite of extensive efforts by this same man to eliminate the coyote.) Today there are coyotes in nearly every state--in pioneer days there were none east of the Mississippi.

The passenger pigeon, once counted in the millions in his migratory flights, could not survive man's rapid changing of <u>deciduous</u> forests to farmland, and vanished from the skies.

There have been many changes in this land and its condition since settlement began. These changes have had a dramatic impact upon our wildlife. Grasslands were overgrazed and when the grasses were replaced by less desirable plants, so also were the wildlife species changed and replaced. Forests were cut for their timber or to clear land for farming. Lush bottomlands were "corned" or "cottoned" to death and our grandfathers

abandoned these lands and moved further west to start the process over again. An old farmer was once quoted as saying: "Young man, don't tell me how to farm--I've done wore out three farms."

This "rape" of America's lands was done in ignorance and in order to survive in a harsh new world. Our pioneer ancestors came and found a wilderness--and fought to survive. Can they really be blamed for shooting the grizzly bear who threatened their milk cow or their hogs?--or for shooting too many buffalo when the sale of hides and tongues was a way to feed and clothe their families? We must recognize that the world then was different. There was a philosophy of endless resources and more than enough for everyone. Almost no one understood that resources are finite and that there could be a limit to resource use.

As man moved westward, he hacked out a living from the land. Part of his living was the meat and hides and feathers of wildlife. But much more important were the changes he made in the land--as dams were built and swamps drained, as grasslands became dry farms and then dust bowls, as rivers were channelized, wildlife was displaced or eliminated.

Today America is still witnessing a fantastic growth: massive construction projects, agricultural expansion and increasing use of land for homes, industry and recreation. Much of this has a dramatic effect on wildlife, far too often detrimental. But today, unlike in the past, there are knowledgeable, concerned people trying to alleviate and to mitigate harm done to wildlife and its habitat.

One of the basic principles of wildlife conservation is that wildlife is a product of its habitat. Wildlife is a product of the land and the existing conditions on that land. This understanding can help us to benefit wildlife in the future. You are able to control your environment with clothing, air conditioning and piped-in water. You can live anywhere in America. Few wildlife species are so adaptable; wildlife depends upon a stable environment.

Concern for wildlife began surprisingly early in America with laws restricting the harvest of deer in Massachusetts in 1718, and with laws protecting species from overhunting or overfishing. Even prior to American settlement, Kublai Khan (A.D. 1259-1294) controlled the harvest of species. English kings set seasons and bag limits on deer, grouse and salmon.

A major change that has benefited wildlife has been the creation of state game and fish departments and federal wildlife agencies. These agencies were charged with the care, protection and management of the wildlife resource. This was perhaps the first far-reaching action taken towards the conservation of American wildlife. It eventually put professional biologists and law enforcement people in a position to protect the resource and search for the ecological facts needed to perpetuate wildlife as a valuable national resource.

The history of these agencies is one of evolution, from a purely defensive or protective concept to complex management. Research, habitat protection, environmental study, education and management have been added to protective action. The change has been from the politically appointed "game warden" to today's requirements for degrees in wildlife biology or ecology--where agencies commonly have Ph.D.'s on their staffs, and wildlife managers and law enforcement specialists are university trained.

Looking into the future, it is difficult to foresee anything but a continued deterioration of our environment, and in particular, a loss of wildlife habitat. As our human population occupies more of the land and utilizes more of its resources, we leave less land, less water, and less plant resources for our wildlife neighbors.

We must understand that in the years to come there will be less wildlife than now exists, and we must understand why. We must understand that if this occurs it is because we have made the decision that these lands must accommodate man first, and wildlife second. Let us be sure that such decisions are carefully considered for alternatives. And let us never accept the loss of any species. In our environments there must always be room for at least a remnant of each.

We will never see the surging herds of buffalo our grandfathers found on the central plains, but somewhere, there must be room for herds of a size compatible to today's world. Surely we cannot expect the thousands of deer, quail and other species that are now a part of our environment; but we must make sure that there are always canyons and fence-rows, forests and woodlots, deserts and salt marshes that we can spare for the preservation of such wildlife resources.

America can continue to be blessed with the wonder of wildlife--or it can become bleak, ugly and minus this most precious resource. We could, perhaps, live without robins and squirrels or deer and black bears, but we cannot live without wildlife in its broadest context. It is up to us to make the future. The challenge is now--the responsibility is ours.

If we will learn, and teach well, the five basic concepts of wildlife conservation covered in this guide, if we understand and act upon them, there will always be a place for wildlife in our crowded and shrinking world.

These five concepts are really "what it's all about:"

1. Wildlife is a product of its habitat.

2. Wildlife species are interdependent with one another and with their environments.

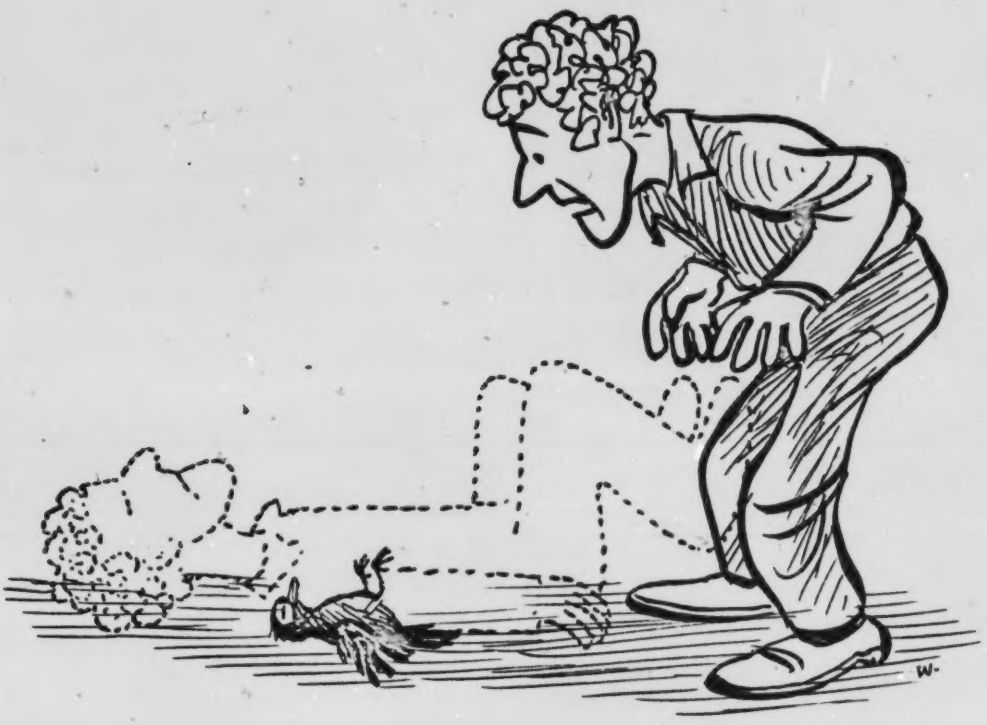
3. Wildlife populations and their environments are not static but are in constant change.

4. Wildlife is a renewable resource.

5. Man has been an important factor affecting plant and animal succession and other environmental processes.

These five concepts, and their understandings, contain the basic knowledge that is imperative for us all to have in reference to wildlife conservation, and wildlife as a part of our environment.

By making these concepts a part of your lesson plans and your students' understanding, you can help to assure the future of wildlife and a better world for your students.



GOALS

Children should develop understanding of the basic functions of nature. They need to learn that things don't "just happen."

Students should be led to develop interests in living things that carry over into leisure-time activities.

They should learn to appreciate all living things--there should be no concept of "good" or "bad."

Students need to know that all living things are interdependent, that there can be no isolation of one from another, nor from their very specific habitats.

They need to learn that people have, and must accept, responsibilities to the natural world.

And children must learn their own importance--that they can help with conservation and with environmental problems.

These goals can be achieved.

In the primary grades, children should learn by observation and should learn to determine what really is happening.

At the intermediate level, observation should include critical comparison and utilize simple techniques of measurement.

The junior high school student should progress to comparative measurement, sustained experiments, calculation of results and the beginnings of an evaluative process.

Thornton Burgess, beloved author of the "Peter Rabbit" series said, "In the study of nature lies the key to the most successful mental, moral and spiritual development of the child."

BASIC CONCEPT #1

WILDLIFE IS A PRODUCT OF ITS HABITAT

Here is a sample activity to use with the concept. Further activities can be found in the "action" section.

Suggested activity - Mathematics

* * * * * * * * * * * * * * *

Some animals can tell temperature:

A cricket can tell you how warm it is. During warm weather his chirp is rapid and high-pitched. During cooler periods, his chirp slows. By using the following formula, you can determine the temperature from the number of chirps per minute.

(N = Number of chirps per minute)

Tree cricket –

$$\text{Temperature} = 50 + \frac{N - 90}{4.7}$$

House cricket –

$$\text{Temperature} = 50 + \frac{N - 40}{4}$$

Katydid –

$$\text{Temperature} = 50 + \frac{N - 19}{3}$$

The problems can be reversed: The temperature is 78°. How many times per minute would each cricket chirp at this temperature?

Or: If it is 78 degrees, which kind of cricket is chirping?

At times cricket calling may not be readily available. Toy mechanical "clickers" often found in Crackerjack boxes might be used to simulate the cricket's call.

What does this show about a cricket and his relationship to his environment? Is temperature a part of environment? When his chirping is slowed, are all his body functions reduced also? Would you expect to find crickets in polar regions? Why?

Be certain you check temperature where the cricket is--not where you may be listening from.

* * * * * * * * * * * * * * *

Understandings:

A. Environment determines the kind of wildlife in a community.

The physical and climatic features of a given area, its elevation, rainfall and topography, plant communities, microclimates, the chemical constituents of the soil, the historical activity of fire, man's use or abuse, glacial or volcanic action--all of these things, and many more, help to determine the species and numbers of wildlife in a community.

A comprehensive description of an environment--here in America or in any part of the world--will predict specific types of resident wildlife.

In a California desert we might find a kitfox; in a similar African desert area we would find a bat-eared fox--a very similar animal. The grizzly bear of North America can be compared to the European brown bear--each lives in a very comparable habitat.

In each case the comparative ecological niche is filled by a similar animal.

B. Each biome has a characteristic life.

The biome is the largest community unit which is convenient to recognize. In a given biome the climax vegetation is the same--in the grassland biome the climax vegetation is grass (perhaps varied species of grass in different areas of the biome, but grass as the dominant plant.) In a chaparral biome, brush is dominant and in the coniferous forest, pines and firs are dominant species. The dominant plant reflects the major aspect of climate and largely determines the habitat for wildlife.

C. Every habitat has a set carrying capacity.

A unit of habitat has precise and limited capacities, just as a particular piece of farmland has its fenced boundaries and specific ability to produce.

The farm can produce only so many bushels of corn, bales of cotton, or units of livestock, unless modified by seeding, fertilization, more water, mulching, etc. This potential remains fairly constant. And so it is with any unit of habitat--it can produce only so many horseflies, fence lizards, bobolinks, catfish, red foxes or moose. Habitat is the key to the populations of any wildlife species. This habitat has a carrying capacity varying from day to day, season to season, but with precise limitations at any particular time.

D. The five essentials of wildlife habitat are: food, water, shelter or cover, space and the arrangement of these elements in relation to each other.

It is easy to understand that wildlife needs food and water and shelter--but when we begin to define these simple words in relation to various species, it becomes very complex and fascinating. For example:

Cover or shelter means not only cover to hide in, but cover to travel in, cover as shelter from the elements (one type for hot weather, another for cold), cover for stalking, cover for breeding, cover for natal activities and cover for bedding.

Understanding the concept of food means a consideration of species, season, "good or bad" year, competitors, available shelter--and more.

Water needs can vary from those of a kangaroo rat, which uses no free water, to the needs of a fish which must live in water, travel in water, find food in water, shelter and reproduce in water.

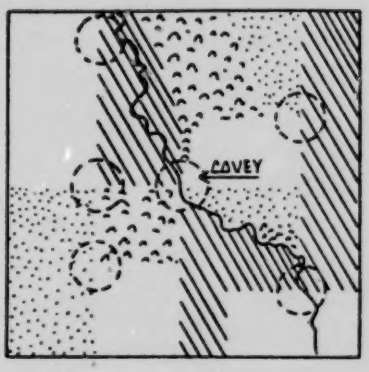
Another wildlife requirement is space, or territory--again varying with species. A nesting wren may defend a territory of only a few hundred square feet; a mountain lion may claim a hundred and fifty square miles. A wolf will mark the boundaries of his territory just as we fence our property; a cardinal will vigorously evict another cardinal from his private kingdom, but ignore the bluebird in the same tree. Territory is an important understanding when learning about wildlife.

Food, water and shelter must also be properly arranged for the particular species of wildlife to make use of it. When the food is too far from the bedding shelter and the water is too far from escape cover, the habitat is not suitable for wildlife. Each species has its own measurement of these distances. The waterhole that might be too far for a porcupine or a tree squirrel might not be too far for a mourning dove or an elk.

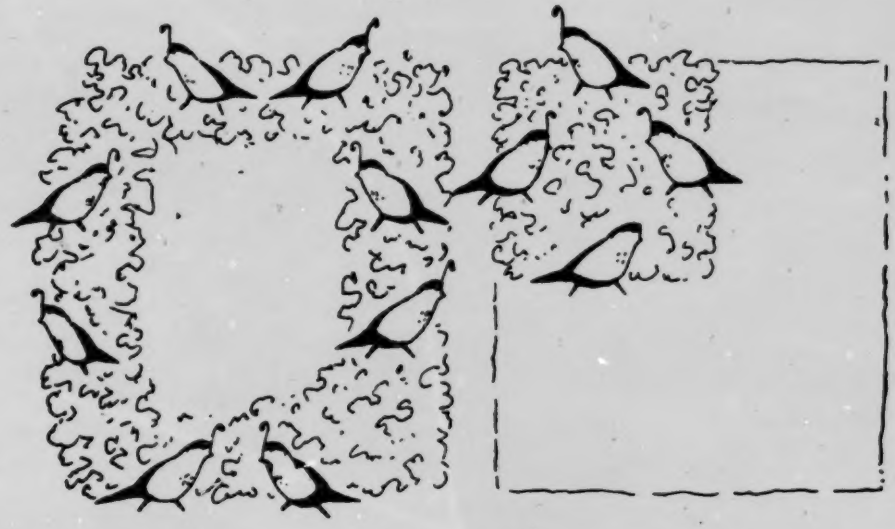
If, in your community, we moved all bathrooms to the farthest north edge of town, all bedrooms to the extreme south, all grocery stores to the next county to the east, and the water supply ten miles west, how many people would continue to live in your town? This is how it works for wildlife as well.

Look at these diagrams; they illustrate this point.

Poor edge-effect (1 covey)



Good edge-effect (6 coveys)



Distribution of food and cover is important. Ten acres of cover surrounding a field is more effective than a ten-acre square in one corner. This is also referred to as the concept of edge effect. The edges where one biome meets another is habitat for more animals and more species than either of the biomes individually.

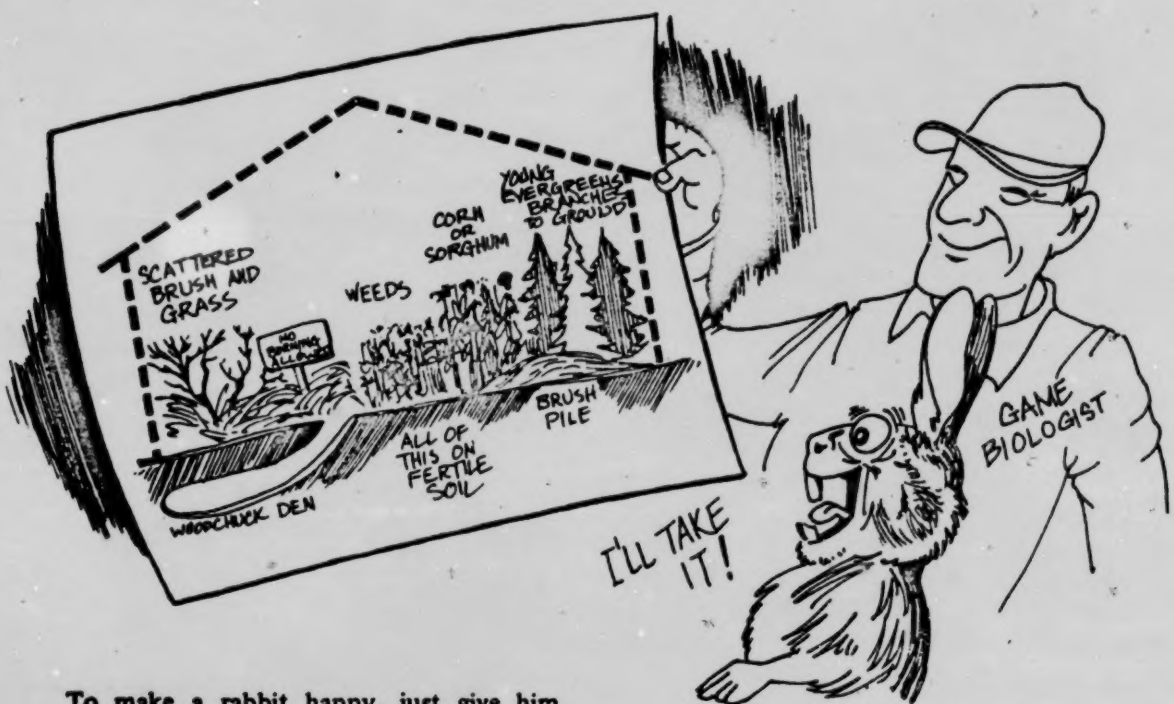
E. In any environment, one component like water, air, light, or food may become a limiting factor. When these, or other resources, are in short supply, or in excess to the tolerances of an organism, they are said to be "limiting factors."

If a lake is muddied by erosion on the surrounding watershed, sunlight can no longer penetrate the water. Without sunlight the microscopic plants (primary producers) which live in the lake, cannot grow. Without these plants the food chain of plankton-aquatic insect-minnow-large fish is broken. The limiting factor of the large fish population then becomes the food supply, in this case the lack of minnows. But indirectly, the lack of sunlight was the limiting factor. Because of soil erosion there are no fish in the lake.

F. Wildlife resources are limited in quantity, quality and distribution.

Wildlife population levels are determined by the quality and quantity of habitat. Some habitats have a higher "carrying capacity" than others and can support a higher density of animals. For example: there is more pronghorn (antelope) habitat in Wyoming than in Arizona and consequently a larger total population of antelope, even though "density" (pronghorn per square mile) might be as high or higher in Arizona.

Many rabbits will be found in an ideal habitat such as that depicted below.



To make a rabbit happy, just give him food, nesting cover, winter protection, and predator escape thickets. Happy rabbits mean more rabbits.

G. <u>Regulations, although desirable for good wildlife conservation, cannot substitute for good habitat, or save a species whose habitat has been depleted or destroyed</u>.

There is no substitute for good wildlife habitat.

Laws and regulations protecting wildlife are important and desirable, but will not produce wildlife. A refuge is of no value unless it contains the five basic elements of habitat needed by the species to be protected.

The reduction or loss of a population is more quickly and completely done by habitat destruction than by any combination of hunting, poaching, trapping or even deliberate vandalism. A species can only be preserved and made to prosper by preservation and improvement of its habitat.

BASIC CONCEPT #2

WILDLIFE SPECIES ARE INTERDEPENDENT WITH ONE ANOTHER AND WITH THEIR ENVIRONMENTS

Here is a sample activity to use with the concept.

Suggested activities: Science, Social Studies, Music

* * * * * * * * * * * * * * *

The Food Chain Game - The Web of Life

A game which demonstrates interdependence between living organisms and their environments.

Equipment needed: a large ball of string or colored yarn and a small sign for each participant.

Procedure:

Make a sign for each student. The signs can be simply lettered or a project for your art class.

Each sign should represent some element of the environment. Start off by using the immediate neighborhood. Suggested signs could be: sun, water, air, soil, native plants--grasses, trees, bushes. Now add some of man's plants such as corn, wheat, apple trees; native animals--herbivores, carnivores, omnivores, decomposers. Add domestic animals. Make the list fit your community.

Seat the students in a tight circle; give each student his sign. Using an inquiry technique, start the flow of energy from the sun--where does it go and how? When the web is complete, talk about what happens to the web when something happens to any unit. Add in your own problems--a forest fire, flood, drainage project, etc.

Try the Web of Life in social studies by substituting elements of the man-made community: a church, service station, bank, lumber mill, grocery store--what are the relationships and interrelationships?

Use the Web in music--have your students portray instruments in an orchestra. How does each instrument relate to the final sound?

Try different ecosystems--desert, forest, polar ice, African veldt. There is almost no end to the teaching capacity of this game.

* * * * * * * * * * * * * * *

Understandings:

A. Living things interchange energy and matter with the environment and with each other.

The essence of life begins with light from the sun, and it is continued by the transference of this energy from sun to plant to animal.

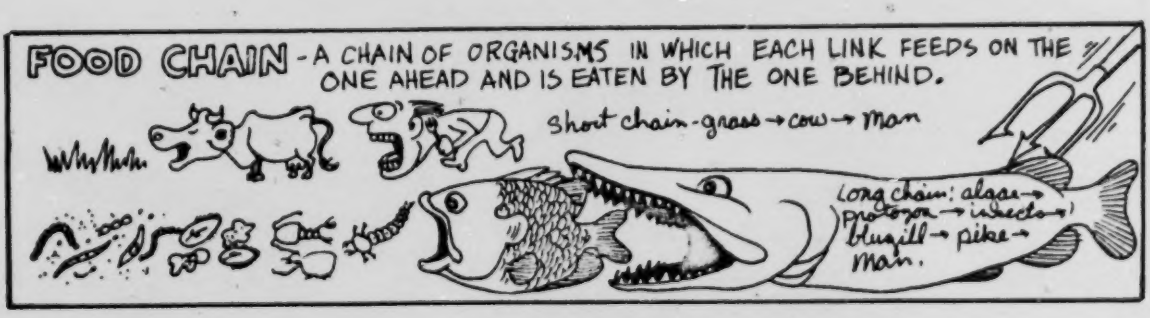
This connecting of energy--organism to organism--is called a "food chain." Each organism has its own very specific food chain which may overlap that of other organisms. The interlocking pattern of these food chains is sometimes called the "food web" or the "web or life." Through this fantastically complex web flows energy and matter, circulating from organism to organism and from organism to environment.

B. The comprehension of food chains and food webs is basic to understanding wildlife conservation and management.

An elementary knowledge of wildlife is that animals must eat, and that their food must be of a proper quality and quantity. Each living thing, from micro-organism to Boy Scout, has a specific food chain to supply this need.

The food chain illustrated here shows only one part of the food chain of the fisherman. Remove the fisherman from the scene and it becomes the food chain of the pike. Remove the pike and what remains is the food chain of the bluegill.

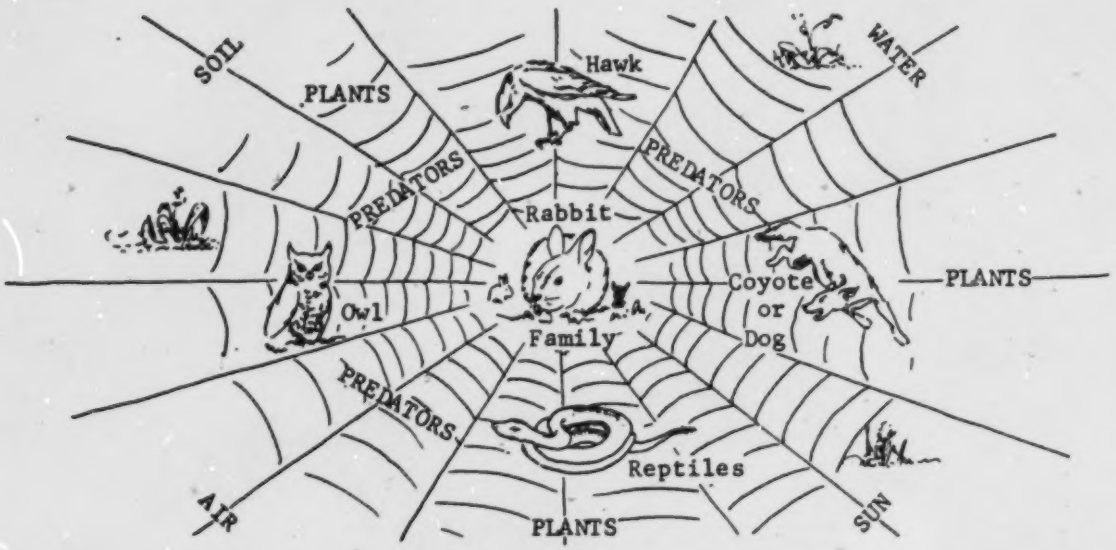
The complexities and interactions of food chains must be understood if we are to manage and conserve wildlife. For example: a refuge cannot benefit a species unless it contains the food chain of that species.


FOOD CHAIN - A CHAIN OF ORGANISMS IN WHICH EACH LINK FEEDS ON THE ONE AHEAD AND IS EATEN BY THE ONE BEHIND.
Short chain - grass → cow → man
Long chain: algae → protozoa → insects → bluegill → pike → man.

C. Living things are interrelated to each other as demonstrated by the food web of a given community.

We have learned that each living thing has a food chain. Now we learn that these food chains overlap and interconnect--that the cottontail is eaten not only by the coyote, but by the owl, the snake, the bobcat, the hawk and others. The flying insect may be part of a food chain for a skink or a skunk, a snake or a raccoon, a trout or a sparrow hawk. Grass may be eaten by rodent, bird or buffalo.

WEB OF LIFE



D. All wildlife have individual, specific living requirements yet are interdependent with their environments.

Each species of wildlife--earthworm or eagle, chipmunk, salamander or elk--have specific needs, specific living requirements. The soil must have a specific moisture content for the earthworm; specific conditions must exist for the eagle to build her nest; ground cover must be available for the chipmunk's scurryings; a transitional availability from water to land and return are necessary to the salamander; and the gray whale must seek warm lagoons in Mexico for calving and breeding. Unless the specific needs are satisfied, these creatures would not be present. These are only some of their involvements with their environment.

In turn, the earthworm helps to aerate the soil of the mountain meadow; the elk's droppings stimulate the growth of grasses--grasses

which hold moisture in the soil and supply food for the elk and other wildlife. Grass seeds provide food for the rodent or wild turkey, which may be eaten by the eagle. So, the earthworm affects the elk and the elk the eagle. All nature shows these fascinating patterns.

E. Certain natural processes, generally occurring as cycles (hydrogen, nitrogen, carbon, water), influence the interrelationships of living things and affect the physical world.

Both plants and deer receive water from, and lose water to, the atmosphere. A deer may obtain needed moisture from its plant food, and its body discharges of moisture may be used by another plant.

These interrelationships between a deer and its food are only details in the natural water cycle, and this is just one relationship affected by one natural process. In another condition of the cycle, water may erode a hillside, uproot and destroy plants and even drown the deer.

F. Living things respond to their environment.

All living things respond in a positive or negative way to their environment. When an environment shows increased value (with reference to this single living thing) the organism responds by increasing growth, life span, health, and most commonly, by increased reproduction. In a deteriorating environment the organism shows stress, starvation, and a reduced reproductive potential.

On a good browse range, a mature mule deer doe will annually produce two fawns, and these fawns will have a good chance of survival. On a poor, or overgrazed range, this doe may give birth to only a single fawn whose chances of reaching maturity are slim.

Food is, of course, only a part of this environment and a parallel reaction will be seen when other parts of the environment are involved. Environmental quality may be seasonal; thus a drought, hard winter, or a range fire will produce a response in health or reproduction.

G. Wildlife resources are vulnerable to depletion in quantity and quality. They vary in susceptibility to this depletion.

Some wildlife species are more easily damaged than others. Those species which are very specific in food needs can be decimated by the loss of, or damage to, a food supply. Fish-eating birds are an example: when water is polluted, fish die and waterbirds starve or migrate. If fish have too much pesticide deposited in their fatty tissues, the birds' eggs may not hatch. Either way, the waterbird population is reduced. These fish-eating waterbirds are susceptible to population losses.

Coyotes, for an opposite example, are opportunists. They can and will eat carrion, rodents, deer, insects, or fruit--depending upon availability--and if all else fails, will raid your garbage can or eat your cat. A coyote population is not very vulnerable to depletion.

H. Species and environmental factors interact to keep animal populations in balance with the community.

Some wildlife species compete with others for food, space, water, or other needs. Some wildlife species are neutral in effect upon each other; still others are mutually beneficial, or one may benefit another without harm or help to itself. Some species are parasitic upon another, some are predaceous. (The predator kills for food; the parasite lives upon the host, usually without killing).

Each of these relationships have important effects upon one or both of the species.

A whitetailed deer and a wild turkey may compete for autumn acorns, and a badger may dig for the same rodents that the bobcat stalks by moonlight. A zebra-tailed lizard and a gila monster may have a completely neutral relationship.

The prairie dog supplies food for the black-footed ferret, and yet without the ferret to help control his numbers, the prairie dog might soon overpopulate his towns and rampant disease could decimate his population. So the prairie dog and the ferret are mutually beneficial.

A coyote may follow the lumbering badger and watch his laborious digging for rodents--and catch those rodents that escape the badger's grasp. So the coyote benefits from the badger's efforts.

Environmental factors such as water, light, moisture and temperature, working together, also affect and control wildlife in complex ways. The desert spadefoot toad reappears for his nuptial ceremonies and reproduces his kind only with the summer rains. Temperature controls the hatching of the brook trout or leopard frog egg--temperature and moisture working together create the humidity necessary for a quail egg to hatch, and the lengthening hours of daylight in the spring trigger the nesting of the wild turkey.

This wondrous chain of reactions to environmental factors, and to other species, constitutes an endless and fascinating study.

I. The addition or removal of a species from a community may create harmful or beneficial reactions within the environment of a species.

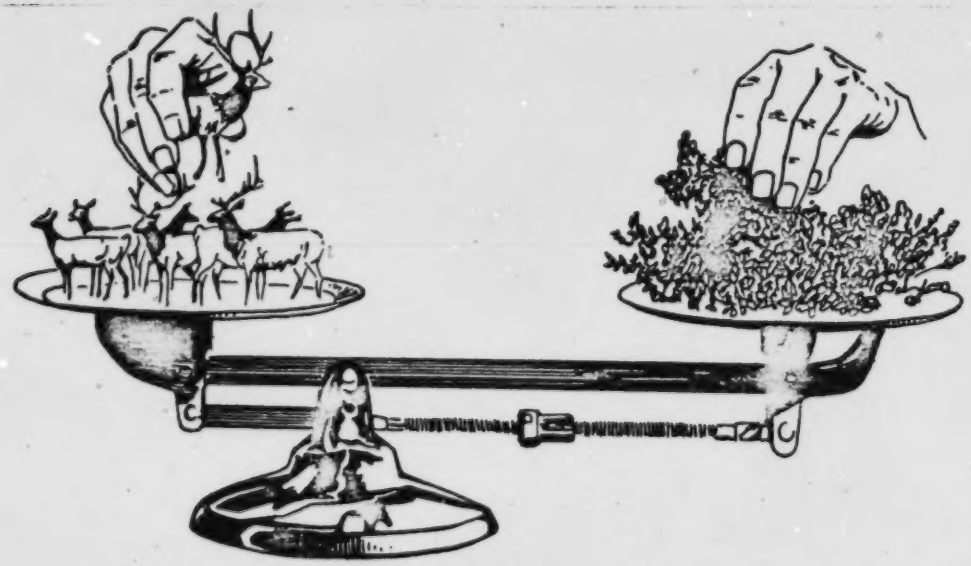
Quitobaquito (kee-toe-bah-kee-toe) is a desert stock pond fed by a spring on the Organ Pipe Cactus National Monument in Arizona. This small body of water contains a remnant population of a tiny one-inch fish

called the desert pupfish. This is the only known population of this particular fish in Arizona, and perhaps anywhere. Recently, someone introduced another small fish, the western goldenshiner, to these waters. The shiner is larger, a more active competitor for food, cover and space, and might well have supplanted the endangered pupfish by simply crowding it out. Quitobaquito had to be drained and treated to remove the threatening shiners in order to preserve the endangered pupfish. The addition of an exotic species endangered the native species.

Some lakes have excellent plankton growth and good aquatic insect life, but the next step up the food chain (which is minnows) is inadequate. There are no small native fishes to fill this niche in the food chain.

Fisheries biologists (after careful investigation and evaluation) sometimes introduce a small fish such as the threadfin shad to these lakes. The shad is a small, silvery fish which is very prolific and seldom gets more than four or five inches in length. The idea is to complete the food chain of the black bass, a species much desired by fishermen. Bass, with this addition to the food chain, increase growth tremendously. Year-old bass averaged about three-quarters of a pound before the introduction of shad to the studied lake; yearling bass, after shad were introduced nearly doubled in weight.

The addition of a species to the community in this case has helped the native fish. The introduction of exotic organisms to a community thus may be either beneficial or detrimental.



BASIC CONCEPT #3

WILDLIFE POPULATIONS AND THEIR ENVIRONMENTS

ARE NOT STATIC BUT ARE IN CONSTANT CHANGE

Here is a sample activity to use with this concept.

Suggested activity: Science, Art

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Make a Bird Calendar

Use drawings or cut out pictures of birds to indicate dates when the birds were seen.

Gather your data and make drawings over a full year. Then add to your calendar year after year. Discuss where and why each bird was seen. Was the bird migrating? Had the bird come to that spot for a particular food or for water? Would that food or water be available only at certain times of the year? Are changes of habitat responsible for his presence? Are these habitat changes seasonal?

Make a scrapbook of birds seen and identified by the class.

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Understandings:

A. Succession is the gradual and continuous replacement of one kind of plant or animal by another, and is characterized by gradual changes in species composition.

When plant succession begins in a burned-over forest, plant replaces plant--grasses and weeds change to brush, to birch or aspen, to pine or fir or hardwoods--depending upon location. As plant succession occurs, there is a parallel succession of animal life--mice and gophers to deer, to squirrel. Insects and birds are a part of the pattern--grasshoppers and horned larks in the grass, certain beetles and bush tits in the brushlands, tent caterpillars and woodpeckers in the birches and bark beetles and jays in the climax forest.

These are simple examples. The presence of each of these animal species also helps establish a habitat for a predatory species which depends upon them, in part, for its livelihood.

B. Changing environment affects living things and the more specialized an organism becomes, the less adaptable it is and the less able to survive environmental change.

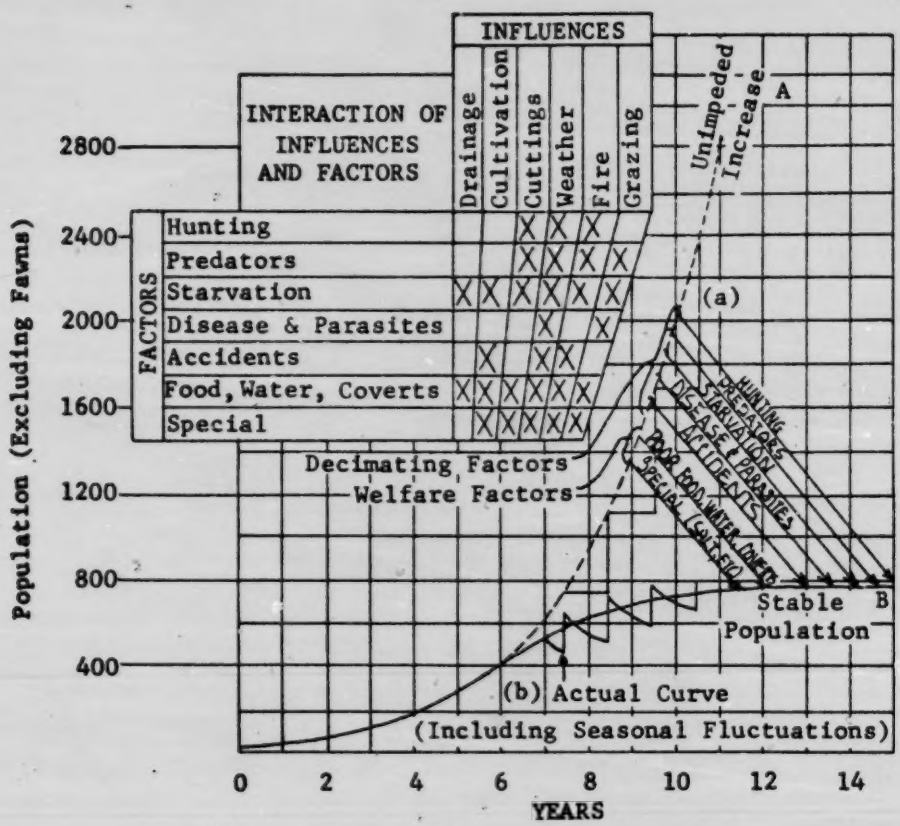
Environmental changes, from whatever cause, have dramatic effects upon all living things. Some are affected more severely than others. Natural changes in environments are often so gradual that species have time to make adaptations; man-made environmental changes usually are so rapid that there is no time for adaptation.

Settlers in the eastern United States cleared great tracts of deciduous forest for farming and thus deprived the passenger pigeon of nesting and roosting areas—and perhaps equally important, the great crops of nuts which were the major source of food for this bird.

As more and more forest was cleared, the doom of the passenger pigeon was sealed. The pigeon could not adapt to this dramatic change in its environment. And of course, to add to the pigeon's woes, it was much sought-after as food and was hunted very heavily commercially. But this factor only hastened the extinction of this interesting bird, loss of its habitat had already sealed its doom.

C. Given sufficient natural resources, a population will continue to increase in size until some limiting factor is imposed.

If a pair of bobwhite quail, in excellent habitat, raised a dozen young a year, it would not be long until we were knee-deep in quail. But we are not up to our kneecaps in quail because other factors than the supply of food, water, cover and space are also involved. Such things as accidents, disease and predation keep this quail population from bursting its seams. The excellence of the habitat and the reproductive potential of the birds tend to increase the population, but the effects of accidents, disease, predation (hunting is a part of this predation) exerts a downward pull and prevents the population from reaching its theoretical maximum. Many species also reach a "saturation point" where social strife sets the ceiling they themselves will tolerate. So there is also a social limit to density. But it is important to understand that no combination of factors ever occurs which enables a wildlife species actually to reach this maximum. The following figure shows these factors at work on a deer population.



D. Living things tend to produce more of themselves than their habitat can support.

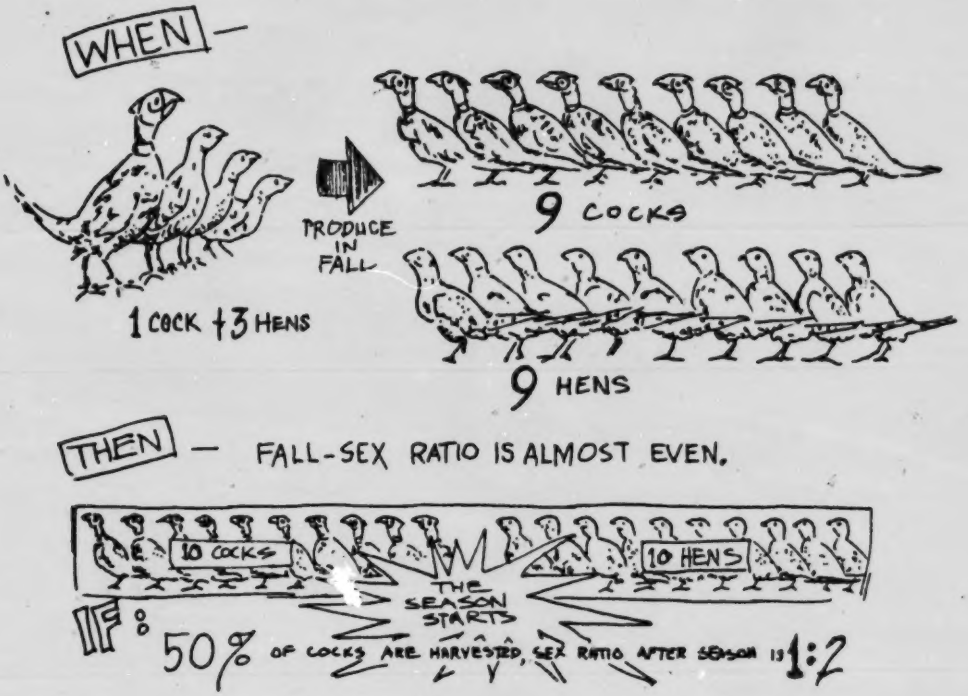
The reproductive capacity of wildlife is completely astonishing. The fact that one pair of quail, if entirely unmolested in an "ideal" environment, could become 1,024 quail in three years--or that a pair of pronghorn antelope, in spite of breeding only once a year and averaging less than two fawns, could increase to ten antelope by the end of the third year--is rather startling. A mature female black bass may lay over 20,000 eggs in one year. A mourning dove may lay only two eggs per nesting, but may nest three times in a summer breeding period. The reproductive potential of insects is legendary.

The potential production of organisms would soon inundate the habitat--the lake would overflow with bass and the southern woodland swarm with bobwhites. In the great scheme of things, this mass production must be matched by numerous factors which tend to repress this increase.

Creatures which are heavily preyed upon, like the cottontail rabbit, are more prolific than others. Prey species have high breeding potentials, which presupposes some natural means to dispose of the surplusage.

Factors of predation, starvation, disease, accident, a reduced quality of food, habitat destruction and the encroachment of civilization all extract a heavy toll from this production. The need of an animal to control a given amount of territory, to "own" a homesite, can limit a population as well. If and when one or more of these factors is partially nullified, a population increase can be expected--to be followed sooner or later by a larger mortality which tilts the balance once more.

"If excess animals are not taken . . . nature will pare them down to fit . . . the habitat."


WHEN —
1 COCK + 3 HENS
PRODUCE IN FALL
9 COCKS
9 HENS
THEN — FALL-SEX RATIO IS ALMOST EVEN.
10 COCKS
10 HENS
THE SEASON STARTS
IF: 50% OF COCKS ARE HARVESTED, SEX RATIO AFTER SEASON IS 1:2

BASIC CONCEPT #4

WILDLIFE IS A RENEWABLE RESOURCE

Here is a sample activity to use with this concept.

Suggested activity: Mathematics

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Ten million ducks are nesting in central Canada. They begin their winter migration to the south. Twenty percent go via the Pacific Flyway, twenty-five percent via the Atlantic Flyway, forty-five percent go down the Mississippi Flyway and ten percent are scattered. How many follow each flyway?

One third of those using the flyway in which your state lies go through your state. How many ducks migrate through your state?

Of the ducks passing through your state, one percent are harvested by hunters. How many ducks are harvested? Is the hunter harvest endangering the duck resource?

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Understandings:

A. Wildlife is considered to be a public resource.

Wildlife, by law, is property of the "state" which, of course, means that it belongs to the people. This originates with the constitution and "states' rights" where states were given jurisdiction over wildlife, except migratory species such as waterfowl. Migratory birds are regulated by treaties with Canada and Mexico. Even here the state has control within boundaries set up by the treaty. The state can be more restrictive than the treaty, but not less restrictive.

Here in America, wildlife was made the property of the "several states" in contrast to the laws of Europe where wildlife was the property of the rulers, and common people could not hunt or fish.

B. Wildlife is not immortal and cannot be stockpiled--nor are all wildlife resources equally abundant.

Most species have relatively short life spans and a tremendous potential to reproduce. A rule of thumb could be "the larger the animal, the longer the life span and the smaller the reproductive capacity--the smaller the animal, the shorter the life span and the greater the reproductive ability."

In smaller animals there is an annual cycle of increase and loss which we call the "annual turnover." In birds, like quail, this population may increase 250% during spring and summer, and decrease to the original numbers by the end of the following winter. January may show 300 birds, July a thousand, and the following January 300 again. A high production rate always indicates a high mortality.

These wildlife resources are based upon the quantity and quality of habitat for that specific species. Thus we may have fantastic populations of katydids and mackerel, but not necessarily equal populations of salamanders or sea cows.

C. A renewable resource can be managed to extend its values, and the harvest of some species of wildlife can be an important tool of this management.

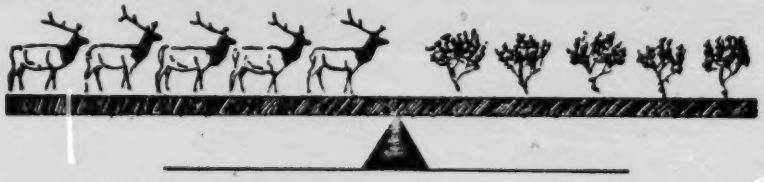
In the harvest of timber on a well-managed forest, trees are cut and made into lumber, paper and other products. New trees are replanted to reforest the area--to be harvested at some future time.

This same concept of management is true of the wildlife resource. Wildlife is renewable and can be used without destruction or damage to the resource.

Large herbivores (deer, elk, moose, etc.) have the capacity to destroy their own habitat when populations increase beyond the carrying capacity of the range. Man, having removed the grizzly, the wolf, and reduced cougar numbers, must now take the place of these predators and remove an annual surplus in order to prevent this destruction. Animal numbers can increase rapidly on a good habitat, but the habitat, once damaged, is slow to recover.

Small game, such as quail, pheasants and rabbits, have a tremendous reproductive potential--and an equally large annual mortality. Man can well afford to harvest a share of this annual mortality rather than letting disease, starvation, accidents, etc. take their toll. Again, man inserts himself into the scheme of things and takes a share.

It is necessary to harvest big game in order to protect habitat, but is is also desirable because of man's benefits from the harvest. With smaller game, the harvest is not necessary, but is desirable and the small game is a valuable resource. Equally important, monies from hunting fees pay for the management and protection for all wildlife species--even unhunted species. Harvesting does no more than utilize a part of the annual surplus--a surplus that will not survive, whether hunted or not.



D. Non-consumptive use of our wildlife resource is advocated by some groups.

There are people who object to the killing of any animal. They oppose hunting as an element of wildlife resource management. Their objectives are philosophical; they feel that because man no longer

needs to hunt for food, he should not hunt. This philosophy objects to the harvest of wildlife for "sport" or recreation.

Some accept harvest as a necessity of good wildlife conservation, but feel that such harvest should be by professional wildlife managers, not by hunters.

E. Certain public agencies are charged with the responsibility of wisely managing the wildlife resource and that management is mostly paid for by fees obtained from the harvest.

The protection and management of wildlife in America is the responsibility of the state game and fish departments, or departments of natural resources and the United States Fish and Wildlife Service.

In most states, a large portion of monies used to manage, protect, conserve or benefit wildlife come directly from the hunter and the fisherman. His licenses, his taxes on sporting goods, and the fines he pays when he breaks game laws, pay for the research into wildlife ecology and new management techniques; protection of all wildlife (not just the hunted or fished for species), preservation, reclamation and improvement of habitat, wildlife conservation education and reintroduction of species--in short, all wildlife conservation work accomplished.

Usually we consider that there are five basic steps to this wildlife management. These are:

Inventory - an understanding of what species are in the land unit being considered and why they are there (habitat evaluation).

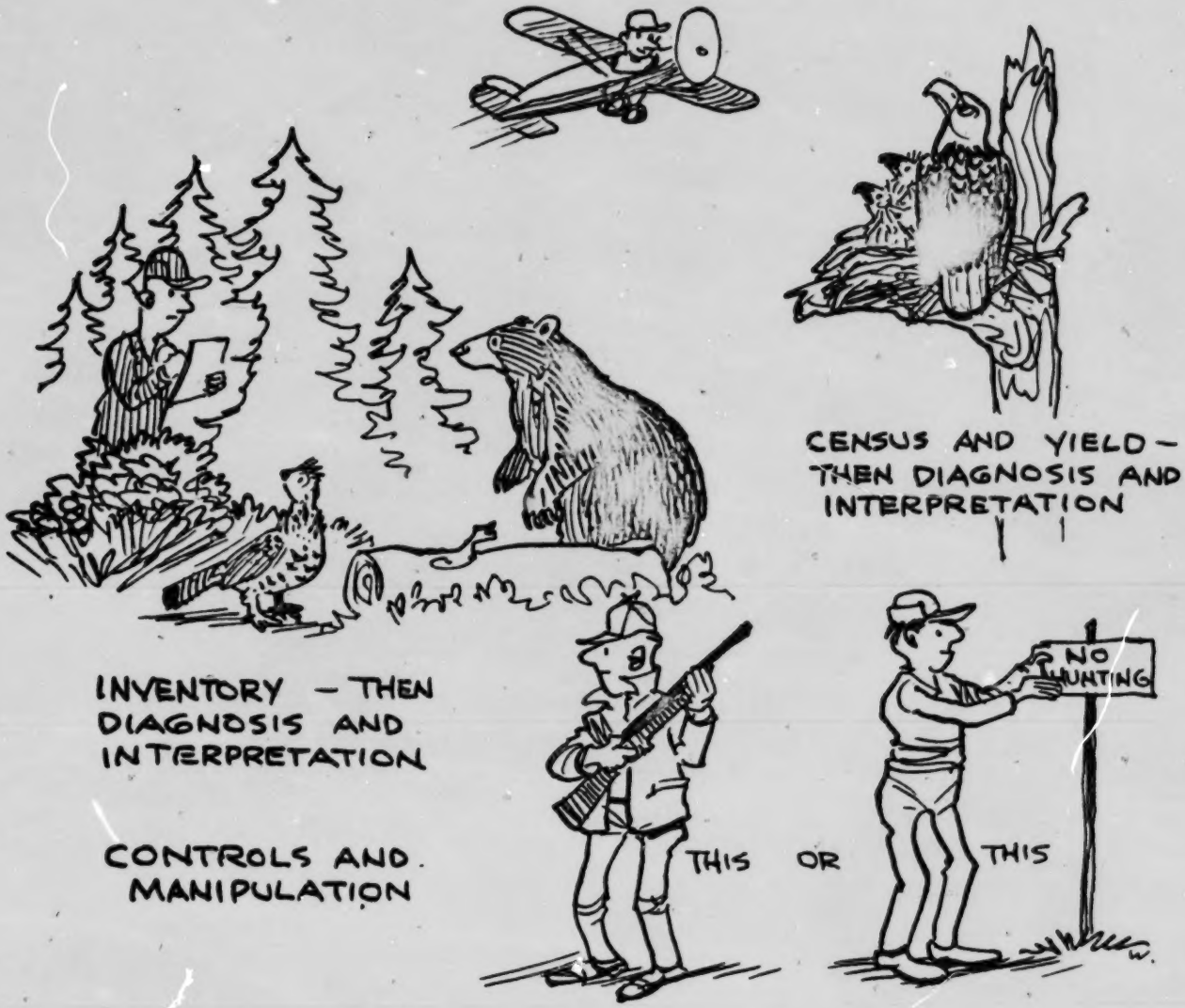
Census - some determination of numbers in the population (how many eagles are there?).

Yield determination - how much is produced, what is the productive capacity of the area for each species?

Diagnosis or Interpretation of these factors - a careful evaluation of the resource and its potential.

Controls and Manipulation of the resource - this could be total protection for an endangered species, very limited harvest on a small population, or an intensive reduction of a herd that threatens its own habitat. Control and manipulation would also include activities to improve habitat for species.

These are the basic concepts, but wildlife management is much more complex than these simple statements.



BASIC CONCEPT #5

MAN IS, AND HAS BEEN, AN IMPORTANT FACTOR

AFFECTING PLANT AND ANIMAL SUCCESSION

AND ENVIRONMENTAL PROCESSES

Here is a sample activity to use with the concept.

Suggested activity: Science

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Pollution and Fish

Using gallon jars for aquariums, fill each jar with clean water (if chlorinated allow to set overnight). Add a small aquatic plant, using clean sand to anchor the plant.

Use as many jars as possible so as to allow the widest scope of alternatives. Place one small fish in each jar. Minnows can be obtained reasonably from fishing bait dealers. Guppies are also common and easily obtained.

Now introduce various pollutants to your little "ecosystems." A great variety of materials can be considered: natural pollutants such as soil or ash (as from a forest fire), and of course many of man's pollutants such as herbicides, pesticides, oil, detergents, soap, sewage, etc. Many items can be introduced by using a "dip stick"--a piece of cardboard lightly sprayed or painted with the pollutant material. Immerse the stick in the water for only a few seconds. Various materials can be used individually or in concert. Varied amounts may also be introduced.

The important feature of this activity is of course the extensive recordings made of the experiment--how much? how long? what effects? what species? different effects on other species, etc. Be sure to keep one aquarium uncontaminated as a control. It is also recommended that when a fish is clearly suffering in his polluted environment he be moved to an uncontaminated aquarium for recovery.

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Understandings:

A. Increasing human populations and technologies require space and activities often inimical to wildlife.

We are all familiar with the predictions for human populations and have seen and felt the dramatic increases all over America. But most of us have not recognized the tremendous effect this has on wildlife through the destruction, alteration and division of wildlife habitat.

The greatest threat to wildlife, not only in America but world-wide, is man's activity in development. When a city expands, when a highway is built, when forests are logged, when livestock is grazed, or when crops replace virgin land, wildlife is vitally affected.

A freeway occupies 20-30 acres of land per mile, but more important than the acreage is the division of that piece of land. This may separate the water from the food or shelter for a species, and so may eliminate the entire square mile as usable habitat for that particular species. Look back at the diagram in Concept #1 D. Imagine a highway

superimposed diagonally across this map. What would this do to the quail in the area?

Impose other activities on the diagram--the results are much the same--wildlife habitat is eliminated.

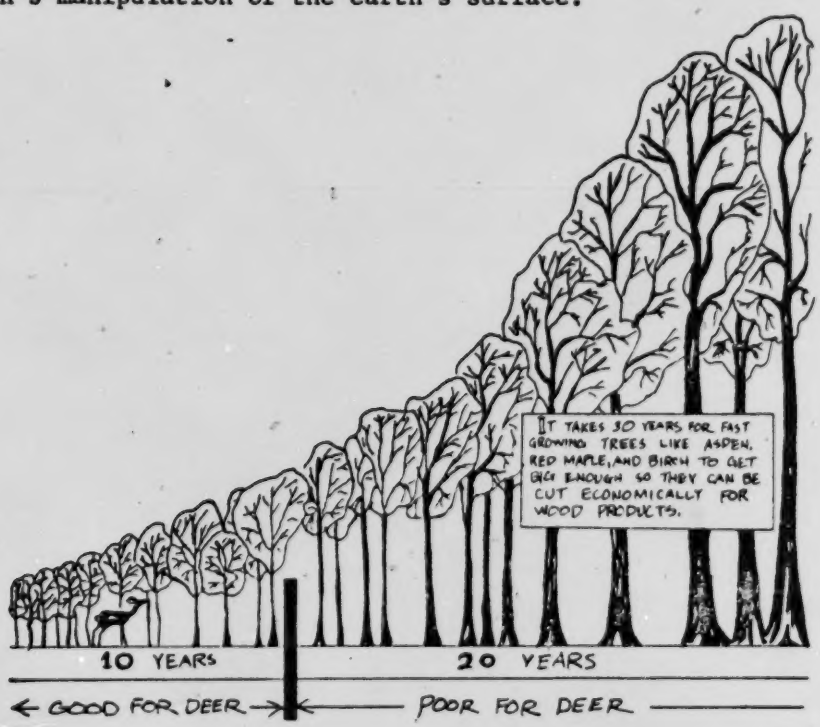
Much of what modern man does in his struggle for "progress" is detrimental to wildlife. Today's harvest of tuna causes the death and waste of hundreds of thousands of porpoises. The tuna is a valuable food, and needed by man, but the loss and waste of porpoises is totally unacceptable. If man cares enough, some compensation can be made, some mitigation of this habitat and species damage.

This we must learn to do--or wildlife will continue to lose.

B. <u>The use made of one resource will affect another adversely or beneficially</u>.

The use of one resource may have important effects upon another resource. These effects can range from highly beneficial to seriously detrimental--but there is an effect.

When a forest is logged, an <u>understory</u> of grass and <u>forbs</u>, bushy plants and young trees begins to vegetate the opened areas. This change of habitat may be highly beneficial to deer (on a short-term basis), but if we look at the needs of Lewis woodpeckers or Fox squirrels, the habitat for them has been damaged or eliminated by this logging activity. This is only one simple example, but it illustrates conflicting effects of man's manipulation of the earth's surface.


IT TAKES 30 YEARS FOR FAST GROWING TREES LIKE ASPEN, RED MAPLE, AND BIRCH TO GET BIG ENOUGH SO THEY CAN BE CUT ECONOMICALLY FOR WOOD PRODUCTS.
10 YEARS
20 YEARS
← GOOD FOR DEER →
POOR FOR DEER

C. Wildlife populations are decreased by many of man's activities.

Almost everything man does has an effect upon some species of wildlife. The effect may be beneficial or detrimental, but too often it is the latter. Some of this harm to wildlife is because man does not care, but most of it is unthinking and unknowing.

The important thing to understand is that all of this loss is not necessary. Damages can be mitigated and alternatives can be taken which are less harmful to wildlife. We abuse our land in many ways--strip and open-pit mining, overgrazing, careless road construction, poor farming techniques, misplaced housing projects--the list is endless. But it is not necessary to damage our environment to this degree.

When a highway is built, it is commonly built the shortest, most economical way. Many times this unnecessarily destroys wildlife habitat. There is more than the shortness of the road and the economy of the moment to be considered. Today's savings of dollars may be tomorrow's loss of a valued resource.

When man farms, he must protect his crop against depredation from insects, so he applies pesticides which damage nearly every animal organism they contact. Different techniques of farming can alleviate this problem and reduce the need for pesticides. Other chemicals can be developed that are less dangerous to the environment, and natural controls can be sought.

In Europe strip mining is done, but with careful attention to returning the land to its ability to produce other values when the mining is completed. Overgrazing can be prevented by carefully balancing livestock (and wildlife) numbers against the plant productivity of the range. Roads and highways can be designed to have a less disruptive effect upon the countryside. Poor farming techniques can be improved and subdivisions can be placed on lesser value lands.

Some of these things will cost you and me a little more money, but it will give us, and our grandchildren, and wildlife a better environment. We cannot afford not to pay these increased costs.

D. Depletion of a wildlife resource can be slowed or halted by protection of habitat, by providing new habitat, or the improvement of existing habitat. The development and adoption of alternatives in habitat use is also most important.

The basic key to greater wildlife numbers is the protection of habitat, the improvement of existing habitat, or the creation of new habitat. Improvements might be: reseeding, development of water sources, manipulation of plant species, reduction of competition (feral burros or livestock), control of disease, establishment of refuges for endangered species and resting areas for migrating birds.

We need alternatives to land-use patterns, total clearing, rechannelization of waterways, freeways, certain pesticides, herbicides and fertilizers. Harvests of wildlife must be controlled, and better management procedures developed. Predator, rodent and feral animal control must consider both the needs of the habitat and the species.

E. Man has at his disposal tools and knowledge to change his environment for better or for worse. Wildlife is the end product of his wise use of the land and water resources.

While there is still much we do not know about our natural environment, and the interrelationships within it, there is much we do understand. We know and understand enough to be able to substantially reduce the habitat and environmental destruction we are doing and have already done. And we know enough to prevent or mitigate much future damage.

Man has produced the tools of destruction: the bulldozer, the dragline, the dredge--and these same tools can be the tools of reclamation and repair. Tools that can drain a marsh or level a mountain can prevent erosion, or reclaim a strip-mined landscape.

The combination of man's increasing knowledge and his capacity to manipulate the physical world around him allows him to change his environment almost as he pleases. He must accept the risk of such activities and must recognize that these actions must be limited and controlled by understandings of their possible consequences. Every act of man which can react upon his environment must be evaluated and accepted or rejected only after careful consideration of these consequences.

F. Wildlife has many values to man and is a most valuable American resource. Man cannot live without wildlife.

Man's relationships to wildlife have changed over the centuries, but not his dependency upon their values. A deer or a beaver was once an important addition to his way of life; now they contribute food and fiber as a secondary importance. Recreation has become the major reason for hunting and fishing--although wildlife as a food is still cherished. Man's dependency upon wildlife has not changed. He still needs the spiders' control of insects, the pollinating activities of butterflies and bees, the rodent control work of the bullsnake, the seed scattering of birds and perhaps even the rooting of the collared peccary, disturbing the earth and allowing percolation of scarce rain and assisting the generation of seeds. The earthworm, the dung beetle, the woodpecker and the carpenter ant all play important parts in man's environment.

Mankind is inspired by the color, grace and uniqueness of wildlife.

G. Adequate wildlife conservation practices depend upon a knowledge and appreciation of natural laws and the application of knowledge from many disciplines. These practices also require long-range planning.

Management of wildlife requires an intimate knowledge of the life history of the animal. It is necessary to understand population dynamics, the ecology of the area, the relationships of species as well as the plant life, its productivity and potential. These knowledges come from study in many disciplines and from practical experience in the field.

All of this and much more, combined with careful, long-range planning, is needed to achieve proper and careful management of the wildlife resource.

H. Man has a moral responsibility for his environmental decisions. The responsibility for preservation of the environment lies with the individual, the community, the state and the nation.

Man, being the only animal capable of completely destroying the environment for himself and other organisms, and being also the only animal capable of mitigating this damage or repairing it, has a moral responsibility to reduce his impact upon the world in which he lives.

An important part of this complex problem is man's exploding population. Just a century ago there was room for all, sufficient resources for man's needs and plenty of space and resources left for wildlife. Today man's increasing demands for resources severely reduce wildlife habitat, depriving animals of food, water and shelter, and cast a blanket of pollution over the earth. All this makes it increasingly difficult for wildlife to prosper, or even to survive. A major understanding should be that man must reduce his own numbers and life style to comply with the limits of his existing habitat. A quality way of life can best be achieved on an understocked habitat.

A land ethic must become a part of each person's way of life. We must learn to realize that land, and all that lives upon it or acts upon it, is not ours to own--to use and abuse as we see fit. Each of us must recognize that he is only in stewardship of these resources. They are only ours temporarily--to use and care for and pass on undiminished in quantity and quality. As we make this an individual way of life, it will become goal and policy and law for community, state and nation.

VOCABULARY

adapted-adaptation -- The process of making adjustments to the environment. Forests develop only where soil types, moisture, and sunlight are balanced to the proper degree. Desert plants have made adjustments so as to be able to live under intense sunlight, on poorer quality soils, and with a much reduced water supply.

aerate ('a(-e)r-'at) -- To supply with air or oxygen. To supply the blood with oxygen as in the function of lungs. To supply running water with additional oxygen as when a stream runs over falls or rapids, or when wind creates waves on a lake.

amphibian (am-'fib-e-en) -- Animals that live partially in an aquatic habitat and partially on dry land. Includes frogs, toads, and salamanders.

animal communities -- Animals of various species live within a certain habitat, each occupying a specific position in this particular environment. Directly parallel and related to plant communities. In a desert area, a coyote, jackrabbit, gopher, snake, elf owl, gecko, scorpion, and a cactus wren may be part of an animal community.

annual turnover -- The rate of replacement of individual animals in a population. Birds, such as quail, may have a 70 percent turnover annually. This means that only 30 percent of the birds alive at the beginning of one year are still alive at the end of the year. The reproductive capability of a species will match the mortality, or turnover rate.

aquatic (a-'kwat'ik) -- Growing, or living in, or frequenting water.

bag limits -- The regulation of numbers allowed in regulated hunting or fishing. A hunter may take 10 mourning doves; a deer hunter may take one deer per year; these are bag limits.

big game -- a hunting term designating larger hunted species, such as: deer, elk, moose, bear, bighorn, etc., as opposed to "small game," such as rabbits, woodchucks, doves, quail, etc. In most states, species are legally designated as big game and small game.

biome ('bi-'om) -- A large geographic area with somewhat uniform climatic conditions. Over a period of time certain plants have adapted themselves to live under these conditions. These plants are dominant in this biome and the biome usually gets its name from one of these dominant plants; i.e., the Forest biome, the Grassland biome, etc.

biotic community -- Commonly, the living organisms in a given community. It would include all plant and animal life within the community. The nonliving parts would be considered the abiotic parts of the community.

blind -- A hiding place for observing.

bounty -- A reward or payment for removing certain species of animals felt to be harmful. This action is slowly going out of practice.

browse ('brauz) -- A general term, commonly used in wildlife management to signify brushy plants utilized by deer, elk, or cattle as feed.

capillaries (kap-e-'ler-e) -- Any of the smallest vessels of the blood-vascular system joining the arterial and nervous systems and forming networks throughout the body.

carnivore ('kar-ne'vor) -- Referring to meat eaters. A carnivore is a meat eater.

carrion -- The bodies of dead animals--usually as found in nature, in the process of decay. Not "fresh" meat.

carrying capacity -- The ability of a given unit of habitat to supply feed, water, cover, and necessary space to a wildlife species. The largest population the unit can support on a year-round basis, or during the most critical season. Varies throughout the year. This number varies from year to year, dependent on conditions within the habitat such as rainfall, competition from domestic animals, etc.

chaparral (shap-e-ral) -- In wildlife work the term describes brushy areas where manzanita, ceanothus, cliffrose, scrub oak, skunk brush, and others are the predominant vegetative types. The term originates from the Spanish and referred to thorny bushes and is also the source of the word "chaps," a part of the cowboy costume. Chaps were originally called "chaparreras"; the word later shortened by Anglo cowboys.

climatic (adj.) -- The average condition of the weather as defined by temperature, precipitation and wind velocities; the environmental conditions relating to weather.

climax -- The final stage of plant or animal succession. When environmental conditions have been stable long enough for an area to develop a semipermanent biome. Rock crumbles, pioneering plants begin to grow in the sandy soil; as they add mulch and humus, other plants follow--from grasses to shrubs, to pine forest. If climatic conditions and soil types are proper, the climax species could be the pine forest. Animal types would follow this pattern of succession, ending perhaps with squirrels, porcupines, and Stellars jays as climax species.

community -- An association of organisms, plant and animal, each occupying a certain position or ecological niche, inhabiting a common environment, and interacting with each other.

coniferous (ko-'nif-e-res) -- Refers to cone-bearing; a coniferous forest is one composed of pines, firs, or spruces.

conservation--wildlife -- The conservation of a renewable resource recognizes that the resource replenishes itself periodically, and that surpluses occur for short periods. These surpluses may be used without damage to the basic resource.

consumer -- The first part of an ecosystem is the nonliving substance; the second part consists of those organisms which are called "producers" or food makers; part three of this system is called the "consumer" because it utilizes the producer for its food. It may in turn be used as food by a secondary consumer. A rabbit is a primary consumer. A fox would be a secondary consumer.

cover -- The vegetation, debris, and irregularities of the land that provide concealment, sleeping, feeding, and breeding areas for wildlife.

covey ('kov-e) -- A small flock or group, often a family group, of birds such as quail.

dabbling ducks -- Ducks which frequent shallow marshes, ponds, and rivers and "tip up" to feed. They feed with body above the water and take off vertically when startled. Also called "puddle ducks." (See diving ducks)

deciduous (di-'sij-e-wes) -- In reference to trees--those that annually shed their leaves; regarding animal teeth--those commonly called "milk teeth."

decomposer ('de-kom-'po-zer) -- Those organisms (bacteria-fungi) which convert dead organic materials into inorganic materials.

deposition ('dep-o-zish-en) -- The depositing of materials, usually soil particles, by flowing water.

depredation ('dep-re-'da-shen) -- The act of preying upon; usually in relation to wildlife damage to man's crops or animals.

desert scrub -- Arid environments with irregular winter rainfall, summer rainfall, or biseasonal rainfall; highly varied plantlife, with leafless, drought deciduous or evergreen species of trees, shrubs, herbs and grasses, yuccas, agaves, and cacti.

diurnal (di-'ern-el) -- Active by daylight; the opposite of nocturnal.

diving ducks -- Ducks which prefer deep water as in lakes and bays. They feed by diving below the surface and take wing from a running start.

dominant species -- Plant or animal species which exert major controlling influence on the community. Removal of dominant species result in important changes in the community. Generally, dominants have the greatest total biomass. (Biomass: total numbers or weight.)

ecological niche ('nich) -- That special place in a community occupied by a given organism. Where an organism lives, where it gathers food, where it seeks shelter. Who are its "friends and enemies," what does it give to the community, what does it take from it, how is it affected by its environment, and how is the environment affected by it? These determine the "place in society" of this organism.

ecology (i-'kal-e-je) -- The study of the relation of organisms or groups of organisms to their environment; or the science of the interrelations between living organisms and their environment.

ecosystem -- Any natural unit that includes living and nonliving parts interacting to produce a stable system in which the exchange of materials between the living and nonliving parts follow closed paths.

edge effect -- The tendency of wildlife to concentrate at the edges of two adjacent vegetative or land-use types. Where deer, for example, concentrate in an area where brush land and meadowland meet because of the extra food and shelter provided by the edge.

endangered -- An "endangered" species is one which is in danger of extinction throughout all or a significant portion of its range. (A threatened species is one that is likely to become endangered).

environment -- The total of all of the surroundings: the air, water, plantlife, human element, wildlife--all that has influence on you and your existence. Both physical and biological factors.

esthetic (aesthetic) -- Relating to or dealing with the beautiful. An esthetic value relates to the value placed on beauty.

exotic -- In conservation language this refers to a foreign plant or animal that has been introduced into a new area. Examples could be the "wild" burro or Ring-necked pheasant.

extinction -- The act of removing from existence. An animal facing extinction is one in danger of vanishing from our world.

feral ('fer-el) -- Used in wildlife as referring to domestic animals gone wild; i.e., burros and "wild" horses, cats, dogs, and swine.

finite -- Having bounds or limits; capable of being counted or measured; the opposite of infinite.

flyway -- Flight routes established by migratory birds.

food chain -- The transfer of food energy from the source in plants through a series of animals, with repeated eating and being eaten.

food web -- Food chains (see above) are not isolated sequences but are interconnected with one another. This interlocking pattern is called the food web.

forage ('for-ij) -- Refers to vegetation taken naturally by herbivorous animals, both wild and domestic.

forbs -- In wildlife usage forbs are weeds and herbs; low-growing annual or perennial herbaceous plants. An important part of wildlife habitat.

habitat -- The complex of soil, water, and plants, commonly called "cover" in which all wildlife exists. It is the "life range" which must include escape cover, winter cover, food and water, cover to rear young, and even cover in which to play.

herbivore ('er-be-vor) -- An herbivore is a plant eater.

hibernation ('hi-ber-'na-shen) -- The act of passing the winter, or a portion of it, in a state of sleep; a torpid or resting state.

insectivorous ('in-sek-'tiv-ores) -- Refers to insect eaters.

interaction -- The relationship of one organism to another. The action of one population affecting the growth or death rate of another population. One population may eat members of the other populations, compete for food, excrete harmful wastes, or otherwise interfere with the other population. Some interactions are positive, some negative, and some completely neutral.

interdependencies -- The interrelationships of wildlife with one another and with the various elements of their environment.

invade -- To enter, to encroach upon, to spread over into. Wildlife use usually refers to when an organism is removed from a community and another organism spreads over into this community.

lichens ('li-ken) -- Algae and fungus growing together in a symbiotic relationship. (Symbiotic: mutually beneficial in this case.) (See mutualism).

limiting factors -- There are many influences in the life history of any animal. When one of these exceeds the limit of tolerance of that animal, it becomes a limiting factor. It then drastically affects the well-being of that animal.

microclimates ('mi-kro-'kli-met) -- The climates of specific small areas are called microclimates. Microclimates are the tiny contrasts to the general climate of the area. A deep, narrow, shadowed canyon--cool and damp--might be a microclimate within a desert mountain range. The shady side of a huge boulder, or the area immediately surrounding a tiny spring would be classified as microclimates.

microorganism ('mi-kro-'or-ge-'niz-em) -- An organism microscopic in size. Able to be seen only through a microscope.

migratory -- In wildlife, birds or other animals which make annual migrations; may be great distances or very short distances, depending on species.

mitigate ('mit-e-'gat) -- To make up for; to substitute some benefit for losses incurred.

mulching -- To add materials to soil in order to protect from cold, to reduce evaporation, to control weeds, or to enrich the soil. Common materials could be sawdust, bark, leaves, cotton linters, etc.

mutualism (myuch-e-we-'liz-em) -- A close association between two different species whereby each species derives some benefit. The yucca plant and the yucca moth each benefit from their relationship.

natal -- Related to birth or being born.

niche -- See ecological niche.

nocturnal (nak-'tern-el) -- Active by night; the opposite of diurnal.

nonrenewable resource -- Those resources which are nonliving--soil, minerals, water, and air; resources which do not regenerate themselves.

omnivore -- An animal which eats both plant and animal material.

parasitic -- To be a parasite on; mistletoe is a parasite growing on trees--it is parasitic.

plankton -- Those organisms suspended in an aquatic habitat which control their own movements. Usually microscopic, and include bacteria, algae, protozoans, rotifers, larvae, and small crustaceans. Phytoplankton are the plant plankton; zooplankton are the animal species.

plant communities -- An association of plants, each occupying a certain position or ecological niche, inhabiting a common environment, and interacting with each other. Dominant plants usually define the community; i.e., a spruce-fir community.

predaceous -- A predaceous animal is a predator who kills and eats other animals.

predation -- The act of preying upon.

predator -- An animal that kills and eats other animals.

predatory -- Predator--an animal that kills and eats other animals.

prey -- Animals that are killed and eaten by other animals.

primary producers -- Green plants which are able to manufacture food from simple organic substances.

pronghorn -- The pronghorn, antilocapra americanus, is the proper name for the American antelope. Not a true antelope, but the only member of its family.

range -- (a) Home Range: The geographic area in which a particular animal occurs. (b) An area grazed by livestock and/or wildlife.

raptor -- Pertaining to eagles, hawks, and owls. Birds which are predatory; preying upon other animals.

reintroduction of species -- A wildlife management technique, where a species is reintroduced into historic range--replanted in areas where it had become extinct.

renewable resource -- Living resources, such as plants and animals, which have the capacity to renew themselves.

resident wildlife -- Animals which are residents to a specific area on a year-round basis, as opposed to migratory.

scavengers ('skav-en-jer) -- An organism that habitually feeds on refuse or carrion. A coyote is a part-time scavenger; a dermestid beetle is a full-time scavenger.

season (open season) -- In wildlife conservation or management--that time when hunting or fishing is permitted for a particular species. May be a single day or year-round.

shelter -- Cover; cover from elements, for natal activity, to travel in, for breeding, for bedding, itc. Varies depending on species.

skink -- Any of a family of small, smooth-scaled lizards.

slough ('slew) -- An inlet from a river; backwater; tideflat; a creek in a marsh.

slough-off ('sluf) -- To shed; to discard as a snake or lizard shedding its skin.

small game -- A hunting term designating smaller hunted species, such as: rabbits, woodchucks, squirrels, doves and quail, etc., as opposed to "big game," such as deer, elk, moose, bear, etc. In most states, species are legally designated as big game and small game.

social limits -- The "saturation point" of a species in an environment. How much crowding will the individual accept. This will vary widely with species.

species -- A population of individuals that are more or less alike, and that are able to breed and produce fertile offspring under natural conditions. A category of biological classification immediately below the genus or subgenus.

static -- Showing little change, usually used in reference to a population or to a condition of habitat.

stewardship -- The concept of land responsibility--that we do not own land but are managers of the resource and responsible to future generations for the condition of the land when we leave it.

stress -- Usually thought of as a physical factor that applies to detrimental pressure to an organism or population. A drought period would apply a stress to a plant community and thereby to an animal population, and this would perhaps inhibit reproduction rather than eliminating the species.

succession -- The orderly, gradual, and continuous replacement of one plant or animal by another.

territory -- The concept of "ownership," or dominance over a unit of habitat. Many species of wildlife are territorial. Best known are certain birds and wolves.

"territorial imperative" -- The instinctive compulsion to gain and defend a territory. Many zoologists believe this drive to be more compelling and persuasive than the sexual urge.

understory -- The layer of plants growing under another higher layer of plants, i.e. grass, weeds and brush under the forest trees.

veldt -- South African grassland, with scattered trees.

vermin ('ver-men) -- Noxious or offensive animals. Animals that are undesirable to some element of our society. The term has been applied to rats, bears, mountain lions, etc. Usually used by someone with a specific but nonecological attitude.

viable -- Capable of living, growing, and developing.

wapiti ('wap-et-e) -- The Indian name for that member of the deer family that we normally call "elk."

waterfowl -- Water birds, usually ducks, but includes shore and wading birds, geese, etc.

wildlife -- As discussed in this manual, it pertains to all living animals.

SUGGESTIONS AND ACTIVITIES

ART

A. MAKE A BIRD TREE

Bring in a dried branch; choose an interesting one, of good size. The branch can be hung on the wall, "planted" in a container, or hung upside down from the ceiling. Have children draw, or cut out, birds to hang on the tree. Bird pictures should be mounted on heavier paper to make them hang well. Birdhouses can also be added, perhaps three-dimensional ones. Birds could also be modeled from styrofoam and covered with colored tissue. Birds can be identified and reports written on their habitats and habits. Children can also build nests to go in the tree.

(Concept 1A) (Primary, Intermediate)

B. WHAT IS IT?

Collect large pictures of animals. Mount on light cardboard. Select the one feature for each animal that is special or is clearly an adaptation--webbed feet for a duck, antlers for a deer, "hands" of a raccoon. Place a piece of opaque paper over the picture and cut out a window which exposes the special feature. Have children try to identify animals from their special features. Talk about where the animal lives, how it is adapted for that place. Questions: What is it? Where does it live? How can you tell the kind of place it lives? What part is showing? etc.

(Concepts 2D, 2F) (Intermediate)

C. WHAT ANIMAL EATS THIS?

Using crayon rubbings, spatter prints, or clay impressions, make a collection of images of various plants. Make a display of plants, which are foods for specific animals. Include the animal's picture in the display. Complete the display with drawings, photographs, or cut-out pictures of the animal's habitat.

(Concept 2A) (Intermediate, Junior High, High School)

D. MAKE FISH PRINTS

Obtain several small, whole fish with scales, fins, and heads intact. Small fish such as bluegill or crappie are excellent. Keep the fish cold until ready for use. Gently wash and dry the fish but do not disturb the scales or fins. Spray the fish with hair spray. (You need work only on one side of each fish.)

Using acrylic paints and a wide, flat brush, stroke color over the fish--taking care to touch every part--including the fins. Wipe color off of the eye. Lift the fish carefully onto clean newspaper.

Lay a trial sheet of paper on top of the fish and hold in place with one hand. Press down gently, but firmly, on the paper with the other hand--head, body, tail, and fins. Try not to let your paper slip. Lift paper carefully to see how the print looks. If you used too much paint the print will be a blob. If too dry, the print will be faint. Use paper towels for trial printing. For finished products use rice paper or other soft papers. Cloth can also make an interesting hanging.

(Concept 1A, 1B) (Intermediate, Junior High)

E. ANIMAL TRACKS

Animal tracks are sometimes hard to obtain for the city school class. Here is a way track casts can be made without leaving the classroom:

Material:

a. book on animal tracks (suggest *Peterson Guide to Animal Tracks* by Murie)
b. 2 or 3 pounds of modeling clay
c. several empty milk cartons (quart size)
d. 10 pounds plaster of Paris
e. gallon can for mixing
f. a shallow box (such as a shirt box, approximately 10" x 16" x 2")

Flatten out clay in the shallow box. Fill the box approximately one inch deep and smooth surface. With a sharp pencil, very lightly draw track on surface of clay. (Can be life-size or whatever proportion you desire. Dog or cat tracks can be used.) With fingers and blunt objects, impress the track into the clay.

Cut milk cartons horizontally into one-inch strips (forming approximately four-inch squares). Place one of these squares around the track and press gently into the clay.

Mix plaster of Paris. Judge the amount of water needed to fill mold, then *add plaster to water*, not vice versa. Add slowly and stir until consistency of pancake batter. Pour into mold and allow to set for 30 minutes or so. Carefully remove mold and cast. Allow to dry face up until hard. Paint as desired.

The clay can be reused again and again by washing off surplus plaster and rekneading.

(Concepts 1A, 1B) (Intermediate, Junior High)

F. FOOD CHAIN MOBILES

Create mobiles of food chains for various species of wildlife. Each class member can make one for a different species. The animals, plants, and other parts may be cut from magazines and posted on cardboard or they can be original artwork. Pieces of plant material, hides, bones, feathers could be included. Be sure that each mobile shows a food chain for a single animal. Or, one very large mobile

might be made up with several animals (a mammal, bird, fish, etc.) showing these interrelationships. Color could be used to code this relationship. Would this be a food web?
(Concepts 2A, 2B, 2E) (Intermediate, Junior High)

G. PHOTO ETCHING

Good wildlife drawings or illustrations can be made from photo prints. Using a large 8 x 10 glossy print, you can make a very acceptable piece of artwork.

Materials: Photo, talcum powder, iodine, India ink, quill pens, a shallow tray, photographic hypo.

Sprinkle your photograph with talcum powder and with soft tissue rub over the surface to remove the gloss. Using the India ink and pens, trace out the parts of the picture you want to work with. Using short lines and crosshatching, work in details and shade the drawing. Do not use large areas of solid black; break them up with lines or dots, etc.

Mix enough iodine and water to fill the tray about 1/2- to 3/4-inch deep. Enough iodine to make "weak tea" will suffice, but a stronger mix will work faster. Place your print in the solution, face up. Rock tray to wash photo. Do not touch the drawing area--it will smear. The photo will slowly disappear and the paper will turn bluish. When the photo image is completely gone, take the photo out of the solution and replace the solution with the "hypo."

The blue color will disappear, leaving only your drawing. Now wash your print for 30 minutes in clear water. Do not touch inked areas.

Allow your print to dry, face up, on absorbent paper towels. Your drawing is complete.

(Junior High, High School)

H. HOW BIG IS AN EAGLE?

Find out by making a set of eagle wings. Using field guides, make scale drawings of eagles in flight, with wings fully extended. Now take a single wing and enlarge it to life-size (see field guides for information). Trace your wing on a large piece of cardboard (large cardboard boxes). Have each student make a pair of wings. Design fastenings or handholds so that students can "wear" the wings. Wings may be painted realistically or feathers can be cut from heavy paper and glued on (again, see bird books). Have children wear the wings to understand the size of an eagle.

Alternatives:

Make a set of eagle wings as an American Indian dancer might. Use authentic designs. How about a record or tape of Indian music and learning to do an eagle dance? Could you perform the dance for other classes? What part did the eagle play in the lives of various tribes?
(Concept 5F) (Intermediate, Junior High)

I. WILDLIFE MAP

From pictures cut out of magazines, or drawn by students, make a display showing what kinds of animals would be found in different parts of your state. Discuss rainfall, temperatures, plant life, topography, etc. How do these affect the distribution of animals? Make a large map to indicate life zones and wildlife.
(Concepts 1A, 1B, 2A) (Primary, Intermediate)

J. WEB SIGNS

Make the signs for the "Food Web Game" to be used later in Science or on a field trip (see "Food Web Game" under Science). The signs can be very graphic. They may be drawings or cut-out pictures or perhaps an exercise in lettering.
(Concepts 1A, 2B, 2C) (Primary, Intermediate)

K. INSECT POSTERS

Make a series of posters advertising insects as: pollinators, soil conditioners, predators, weed eaters, manufacturers, scavengers, or ... Show the insect in its habitat and performing its function.
(Concepts 1A, 2D, 2H) (Intermediate, Junior High)

L. PATTERNS IN NATURE

Many insects and spiders have interesting patterns and designs on their bodies. They also create interesting patterns in their webs, eggs and nests. Make sketches of these. Use these patterns to design something to wear, something for your home or an artifact.
(Concepts 3A, 3B) (Intermediate, Junior High)

ENGLISH

A. USING WILDLIFE IN ENGLISH: A Variety of Ways

1. Have students write a paragraph describing a species of wildlife, its habits, where it lives, what it eats, etc., but without naming the animal. Have other children try to identify the animal from the description. Do not describe the animal physically.

2. Have the children read about various animals (see Bibliography). Discuss life histories. Write poems or haiku using facts as well as fancy. Try cinquain and diamente.

3. Make a radio or television commercial about some aspect of wildlife. Choose an animal and tell about it. Present this to your class. Have children work as teams on television commercials.

4. Make a commercial for an unappealing type of wildlife (a vulture, snake, or skunk). Tape record or video tape your commercials. Play them back.

5. Have the children, individually or in teams, make a list--"*To live I need...*" Make the list as comprehensive as you can. Discuss how this list differs from the needs of any *other* animal. What are the differences, similarities? What items do you need that man makes? Could you possibly live without those? When your list has been reduced by these items, how does it compare with wildlife needs?

6. Write a letter to a friend telling about an animal you saw. Describe what the animal was doing, where the animal was--in the forest, desert, grassland.

7. Perform some drama. Write plays or skits about animals. Do role playing; do pantomime. Try to be as realistic to the animal as possible.

(Concepts 1A, 1D, 2B) (Intermediate, Junior High)

B. WILDLIFE IN LITERATURE

Have students, as a group, name as many animals as possible (mammals, birds, reptiles, amphibians, insects) found in your state. Place animal names on slips and have a drawing. Students are then assigned to research their animal and write a poem, essay, cinquain, etc., about it. Subject? --aesthetics, habits, habitat, characteristics--be innovative. Write a poem about a scorpion, an earthworm, a skunk, or a skink. An essay about the aesthetic values of a snake or a snipe. The characteristics of a bluegill or a chipmunk.

(Concepts 1A, 1D, 2B) (Junior High)

C. EXTINCT WILDLIFE

Write a news story about a wildlife species that has disappeared from your state. Tell why it vanished. Write a follow-up article about animals that are endangered in your state, and why they are endangered.

Write letters to the editor expressing concern, asking what can be done, telling what should be done. Tape record your own broadcast of news about an endangered species and what is being done to preserve it. (Be sure your animal is really endangered.) See the "Red Book"--the U.S. Dept. of Fish and Wildlife book on endangered species. How many animals in your state are listed?
(Concepts 5A, 5C, 5D) (Junior High, High School)

D. BURRO -- BURRO!

The Grand Canyon National Park has determined that there are too many "wild" burros in the park. Set up a simulation game based on the controversy aroused by the Park Service plans. Research the available information (check to see if your information is based on facts of burro ecology or on sentiment). Have children role-play the parts of park superintendent, park rangers and biologists, college professors, wildlife biologists, conservationists, and others involved in the controversy.
(Concept 1C, 1E) (High School)

E. LIBRARY

Have students choose books from the bibliography at the end of this section of the guide. Have them write reports on these wildlife books, or give oral reports before the class. Have the class discuss the report. What were the basic things learned about the animal? Did you already know some of this? Do you agree with the author's interpretation? Do you believe what you read? Discuss.
(Concept 1A, 1E) (Junior High, High School)

F. EAGLE-TURKEY DEBATE

Benjamin Franklin proposed that the wild turkey should be the national bird. Others supported the bald eagle. Have students read about both species and conduct a debate on this subject. Which bird should be our national emblem, and why?
(No Concept) (Junior High, High School)

G. OBITUARY-EPITAPH

Have students learn definitions for the words "obituary" and "epitaph." Have students write obituaries and epitaphs for an assortment of wild animals that have just died. (Remember that insects, birds, arachnids, crustaceans, etc. are all wildlife.) How about an obituary for an earthworm--where he lived, how many children he had, how he died (stepped on by a giant? pulled from the ground by a great red-breasted bird?)

Alternatives:

1. Write news stories about wildlife happenings.

2. Write and tape record radio broadcasts of these news items.

3. Write radio commercials for a variety of wildlife species.

4. Have teams write and give TV commercials for wildlife species.

(Concept 1A, 2C) (Intermediate, Junior High)

H. WILDLIFE ALPHABET

Have children create a wildlife alphabet by naming an animal (insects, birds, reptiles, amphibians, mammals, etc. are all animals) whose name starts with A, B, C, etc. Have each child do this--then write the alphabet on the blackboard and see how many different animals were listed under each letter.

To vary the activity: use only bird names, only mammals, only animals in your state, only African animals, only South American animals, only desert animals. Allow children to research and find names of animals for these kinds of lists.

(Concepts 1A, 1B) (Primary, Intermediate)

MATHEMATICS

A. BUILD A BIRD NEST

Have children build a bird nest, using only the materials a bird might use, and gathering the materials as a bird would--one wisp at a time, one pinch of mud at a time. Mud cannot be made, but must be found. Each item brought in must be worked into the nest. The nest must fit into the forks or branches of a tree (a dry, dead branch can be used and moved inside). Keep accurate records of the time (man-hours) that goes into the nest. Chart this and graph it. How many "birds" worked on the nest? How long would this nest have taken a pair of real birds? The idea is to document the work that goes into a nest.

(Concepts 1B, 1D, 1E) (Intermediate)

B. ANIMAL TRACKS

Find animal tracks in snow, mud, or sand (dog, cat, horse, cow--or wild animals where available). Identify, if possible, but this is not necessary. Measure the distance between tracks--there are several ways this can be done.

1. Measure from one track to the next.

2. Measure the track of a particular foot from one print to that foot's next track.

Try for a variety of tracks--different dog tracks may be of different sizes and should give different measurements. Was the animal walking or running? How many steps would this animal have to take to go 100 yards, 100 meters, a kilometer, a mile? How many steps to go from where you found its tracks to Los Angeles or Washington, D.C., or locations in your state? If the animal makes a certain number of tracks per minute, how long would it take it to travel these distances? Graph and/or chart the data from the different animals. Now, compare to tracks of your schoolmates.

(Concepts 1A, 1B, 2D) (Primary, Intermediate)

C. ACRES -- HECTARES -- SQUARE MILES: BUFFALO

Arizona has two buffalo ranches, one east of Flagstaff and one on the north rim of the Grand Canyon. Raymond Ranch, near Flagstaff, contains 15,717 acres; Houserock Ranch, 67,530 acres. How many square miles are in each ranch? Arizona buffalo ranges are sagebrush-grasslands, and are essentially poor range. On an annual basis, it takes 277 acres of this quality of range to support one buffalo. How many buffalo can live on the Houserock Ranch? Raymond Ranch? Each buffalo consumes about 35 pounds of plant food per day, 365 days per year. How much does a buffalo eat in a year? How much do the buffalo on Houserock Ranch eat in a day? A year? How about Raymond Ranch?

Convert acres into hectares. Convert hectares into square kilometers. Convert pounds of feed into kilograms. How many buffalo can live on the two ranches? How much food is necessary to feed them all for one day, one week, one month, a year?
(Concepts 1C, 1E, 5A) (Intermediate, Junior High)

D. DRINKING WATER

All over the desert areas of the west, wildlife agencies have built waterholes for desert animals. One of the animals most in need of such water is the Desert bighorn sheep. During the hottest summer months, ewes (female sheep) and lambs come to water almost daily. Rams (male sheep) sometimes do not come to water for nearly a week at a time. These rams may travel 20 miles to water. So, if the rams travel 20 miles to water, they have already traveled 20 miles from water, and perhaps 5 miles per day during the week away--that's about 65 miles of travel between drinks. The rams are believed to drink approximately 4 gallons of water when they do come to water. How many miles to the gallon does a ram get? If ewes and lambs come to water daily and a ewe drinks 1 gallon and a lamb drinks 2 pints, how much water does a ewe and her lamb drink per week?

How much water must be available in the waterhole for 10 rams, 16 ewes, and 7 lambs for the months of June, July, and August?
(Concept 1D) (Intermediate, Junior High)

E. BURROS DRINK WATER TOO!

One wild burro, having been without water for 36 hours, and having traveled at least 20 miles, came to the waterhole. A wildlife biologist was keeping track of this burro in order to learn about his way of life. The biologist wanted to see how much water the burro would drink and had prepared an experiment. In 5 minutes at the water, the burro drank 12.2 liters of water. How much did he drink per minute? How much water did this burro need per day? How many gallons is 12.2 liters? If this burro was drinking at the same waterhole as the bighorns (in activity D), how much larger would the waterhole have to be? If he was only one of a herd of 18, how much water would the herd need per day, and for the three summer months? Do you think this competition between burros and bighorns could become a serious situation in dry years?
(Concepts 1C, 1D) (Intermediate, Junior High)

F. DESERT TORTOISE

A desert tortoise has been known to drink up to 40 percent of his weight in water. Weigh a desert tortoise, or find out what one weighs. Figure out the weight of water he could consume. How many centiliters of water? Deciliters? Could he drink a liter? Where does a tortoise usually get most of his water? (From plants that he consumes.) More problems could be made by weighing green plants and then drying them to determine percentage of water in each type of plant.
(Concepts 1A, 1D) (Intermediate, Junior High)

G. DEER HABITAT

Using the information provided, students should calculate answers to the problems listed.

Given:

One acre of meadow can produce 500 pounds of forage per year.

One acre of brush or chaparral can produce 300 pounds of forage per year.

One acre of forest can produce 100 pounds of forage per year.

(Forage: refers to vegetation taken naturally by herbivorous animals, both wild and domestic.)

One adult deer requires 3650 pounds of forage per year, and for the purposes of this problem, 53 percent of this forage comes from the brush or chaparral, 39 percent from the meadow, and the remainder from the forest.

NOTE: These figures are realistic but will vary widely, depending upon local conditions, such as rainfall.

Problems:

1. How many deer can be supported on the area shown? (Conversion factor: one acre = 10 square chains.)

2. How could vegetation be manipulated if your goal was to increase the deer population?

3. What percentage of this deer habitat would be lost if the proposed freeway is built? How many less deer would there be on the area?

4. If the deer need brush, meadow, and forest vegetation, how many deer can live east of the freeway? What percentage of the total herd would the freeway eliminate?

5. What percentage of this deer habitat would be lost if summer homes were built removing one-eighth of the forest? How many deer would be eliminated by the summer home development?

6. What vegetative changes would occur if the timber was harvested by clear-cutting? Partial cutting? What effects would these vegetative changes have on the total deer herd?

7. If you were a Forest Ranger, managing the forest for timber production, and the deer herd increased, what effect might this have on new tree seedlings? What action would you recommend?

8. If the freeway was built, the summer homes developed, and the forest partially cut, how big could the deer herd be? What is the percentage of reduction?

(Concepts 1C, 3B, 5A, 5B) (Junior High)

H. HOW MANY?

Forest soils are alive with tiny soil animals such as mites and earthworms. Studies have shown as many as 9936 may be found in one square foot of forest litter, only two inches deep. How many would be in a cubic foot? A cubic yard? An acre, one foot deep? A cubic meter? A hectare three inches deep?

Discussion: What do they do there? Are they necessary and valuable?

On a field trip, try to find some of these creatures.
(Concepts 2A, 2B, 4B, 4F) (Intermediate, Junior High)

I. HOW LONG DOES IT TAKE?

How long does change take? Using long lengths of adding machine tape, make bar graphs of various biological actions and changes. Use a scale of one inch = one month. Try: gestation periods, time to double a population, to grow various plants to maturity, maturity of various animals, children's growth and life span. (You may have to change the scale for some of these.) Use a blackboard and tape bars on.
(Concepts 3A, 3B, 3D) (Intermediate, Junior High)

J. DEER HERD

One pair of adult deer, living in a good habitat, can produce two fawns per year. Fawns are born 50-50 males and females (bucks and does). Fawns mature at 2 years of age. How many deer would be in this herd at the end of five years? Ten years?

If hunters harvest 10 percent of the mature bucks each year, how many will they harvest the third year? The fifth year? The tenth year? Make a chart or graph of the herd growth and the harvest.

Discussion: What would be the herd size in 25 years? Why are your figures not really "true-to-life?" What are limiting factors? (See glossary.)
(Concepts 3C, 3D, 4B, 4C) (Junior High, High School)

K. ANIMALS CAN TELL FAHRENHEIT

Some animals can tell temperature. A cricket can tell you how warm it is. During warm weather the chirp is rapid and high pitches. During cold periods it slows down. By using the following formula, you can determine the temperature from the number of chirps per minute.

Tree Cricket $- T = 50 + \frac{N - 92}{4.7}$

House Cricket $- T = 50 + \frac{\text{Number of chirps per minute} - 40}{4}$

Katydid $- T = 60 + \frac{N - 19}{3}$

The problem can be reversed: It is 78 degrees; how many times would a cricket chirp per minute at this temperature?

What does this show about a cricket and his relationship to his environment? Is temperature a part of environment? When his chirps are slowed down, are all his body functions probably slowed down too? (Be certain to check your temperatures where the cricket is, not where you may be listening from.)
(Concepts 1B, 2D, 2F) (Junior High)

SOCIAL STUDIES

A. BE A PIONEER

Today we often hear of the "unspoiled continent which was invaded by the European settlers who raped and ravaged a virgin land." It is important that we look at this understanding, relative to those times and conditions. We must first "walk a mile in their moccasins."

Our forebears, as they cleared land, built homes, developed communities, and used available resources, did not see themselves as abusers of the land--and were not regarded as such by their contemporaries. They acted in ways that were consistent with the circumstances in which they found themselves and with their heritage. They came from a world where wildlife belonged to the king and where forests were plainly finite. They came to a world where forests seemingly were limitless and, in some areas, wildlife was equally beyond numbers. When flights of passenger pigeons took hours to pass, and darkened sky, how could they conceive of a limit to that resource? Our ancestors made many mistakes in their use of land and its resources, but this only became apparent later, when viewed by people far removed from the conditions of the time. Hindsight is always better.

This activity explores the pioneer rationale and philosophy of resource use. Students should attempt to understand the attitudes of the pioneer toward his environment.

Divide your students into small groups who will represent families moving into your state in 1820. Have them "homestead" various areas of the state. Have some settle in the mountains, some at the confluence of two rivers, some in a valley. A later comparison of situations and conditions will be very interesting.

Research:

Research existing conditions--vegetative cover, wildlife in the area. Are there Indians nearby and what is their attitude toward you? Research some of these things through reading historical accounts. Check with historical societies and museums for information. There are many references which will give true pictures of life as it really was in those times.

Given:

The family has brought seeds and livestock; all of their resources are in the wagon they drive and the livestock driven behind. Students should make lists of these resources. Make judgments as to weights and whether or not they could *all* be carried in the wagon. What would be left behind?

Once the potential homesite is found, what considerations are there in reference to specific location? What qualities need to be considered? (Slope, drainage, soil type, water, shelter, vegetation, exposure, elevation, etc.)

What are the pioneer's priorities now that he has arrived? List these in order of priority. Take each priority and describe in detail how it would be accomplished. The family may not exceed their own physical capacity to accomplish, nor can they use resources that are not included in their wagon or naturally available. Have students describe processes of getting food, building shelter, providing defense against unknown enemies--animal and human.

Now, have students describe the environmental impact of each activity --the cutting of trees, clearing land, taking wildlife, etc. (Do not warn the students about this step--let them use the land and live on it first.)

When students have completed a study of their impact upon the environment, hold a class discussion on these questions:

1. As a pioneer, what was your attitude toward the land and its resources when you were developing your homesite?

2. Were you much concerned about your impact upon the environment?

3. How does your attitude, as the real you, compare with your pioneer attitude?

4. What factors have contributed to attitudinal changes since those days?

5. Is it unfair or unreasonable to call the pioneers "unthinking despoilers"--that they were "bad guys" because of what they did to the land? Why, or why not?

6. Do you think national attitudes have changed?

7. Should we attempt to judge our actions affecting the environment by current standards and conditions, or by the needs of future generations? What is your reasoning?

(Concepts 5A, 5B, 5C, 5D, 5E) (Junior High, High School)

B. WHO CARES ABOUT WILDLIFE?

Invite representatives from various conservation organizations to meet your class (such as National Audubon, your state Wildlife Federation, Sierra Club, Friends of Animals, etc.) Be sure they are aware of your format and perhaps you may want to give them the questions your students will lead-off with.

Prior to the visit, involve the whole class in formulating questions to be asked by a panel of students in an interview-type program. Schedule the time frame and the number of questions to allow dialogue between the rest of the class and your guest.

Sample questions could be:

1. What is your group's primary objective in regard to wildlife conservation?

2. What is the scope of your organization--statewide, national, international?

3. What is your membership? Is your organization growing or declining in numbers?

4. Do you lobby for legislation and causes?

5. Do you publish a magazine or newsletter? How is it available?

6. What technical expertise does your group have available for your work?

7. What is your annual budget?

8. What are some of your major accomplishments?

9. What areas of concern are you focusing on at this time?

10. What is your position on Wildlife Management?

11. Do you support or oppose the concept of legal, controlled, sport hunting?

After your guest has gone, lead the class in a discussion of the group represented.

Suggestions:

1. Do citizen groups better represent the people in matters of wildlife conservation than governmental agencies? Cite evidence to support your opinion.

2. Is the decision-making process improved or impeded by input from citizen conservation groups? Are quick decisions good or bad? What conditions determine the quality of a decision regarding wildlife conservation?

3. If these groups support or oppose a project, are they of value to society? If so, how? Cite evidence.

The same procedure could be followed, bringing in representatives from industries whose activities may have impact upon wildlife: the forest industry, mining, livestock, or any others which deal with land and/or resources.

Other sources of guests are state and federal agencies--but these people are usually far understaffed and find it very difficult to accept such assignments. Perhaps some study of such agencies could be made, and the students could then role-play the parts of agency representatives.

(Concepts 4A, 4E) (Junior High, High School)

C. WHAT IS THE LAW?

What laws protect and control the use of wildlife in your state? Who administers and enforces these laws? What is the process of enforcement and adjudication? What courts handle wildlife law violations? What are the maximum penalties for the violation of these laws?

Have students discuss the wildlife laws of your state without researching them ahead of time. Have them discuss and record the laws as they think they are.

Obtain copies of state laws regarding wildlife. Have students compare what they thought the law was to what it really is. Look carefully at the definitions used in the law; these are the legal interpretation of these words. These definitions seldom match Webster's, and often, not even common understandings.

Questions for consideration:

Do you agree with the laws as they are?
Who makes laws?
Who makes regulations?
Do such regulations have the force of laws?
What is the difference?

Assign groups to rewrite various sections of the law as they think it should be.

Trace the history of wildlife laws in America, in the world. (See Chapter 1 of *Game Management* by Aldo Leopold and pages 1-13, *Wildlife Law Enforcement*, by William Sigler.)

Questions:

What were the first conservation laws?
Starting with protection alone--what other steps have gone into putting us where we are today in wildlife conservation?
Is America ahead of, or behind, the rest of the world in this area?

(Concept 4E) (Junior High, High School)

D. THE VALUE OF WILDLIFE

Divide your class into two groups. One group will investigate the amount of money spent in your community by hunters and fishermen; the second, the amount spent by nonconsuming "users" of wildlife such as photographers, bird watchers and artists.

Students will use the classified section (yellow pages) of the telephone book as a resource to compile two lists: one of local businesses which cater *directly* to outdoor activities (sporting goods stores, meat processing establishments, photography shops), and the other of businesses *indirectly* related to these "users" of wildlife (motels, service stations, bookstores).

Students should visit businesses on the list and interview the owners or employees to find out what percentage of their income derives from wildlife-related activities. (In smaller communities, particularly in the mountains, this figure may be substantial. Yuma, Arizona motel owners attributed more than $1,000,000 of their income to visiting hunters during only the first seven days of dove season.)

After students have completed their interviews and tabulated their data, discuss these questions:

1. Which form of wildlife use, consuming or nonconsuming, contributes the most to the local economy? Will it continue to contribute the most? Why or why not?

2. Where does the money go which is generated by hunters and fishermen? By nonconsuming users?

3. Does the money spent by either of these groups of users of wildlife represent the real value of wildlife to you? To the community? To the biosphere?

4. Does an endangered species have any value? If so, how would you measure the value? If not, why not?

(Concepts 4A, 4C, 4E) (Intermediate, Junior High, High School)

E. SHALL WE SPRAY?

Ask students to read and respond to this situation:

"Those pesky insects have to be stopped before they destroy the whole citrus crop. Whenever one of those bugs bites into an orange, it leaves a spot--doesn't hurt the fruit a bit--but it marks the skin and people just won't buy a spotted orange. If we don't get in there and spray soon we will lose the crop," stormed the farmer.

"I understand your problem," replied Bob Hartley, the local Wildlife Manager. "But you can't use the poisons you have in mind. I know they are very effective in protecting your oranges, but they are persistent and carry throughout the ecosystem. They destroy the predaceous insects, lizards, and amphibians who eat lots of insects, and we have a lot of different kinds of birds nesting and feeding in the citrus groves. When they eat insects that have died from your poison --and one bird may eat hundreds in a single day--the birds get a terribly heavy shot of the same stuff. If it doesn't kill them directly, it sooner or later affects them via the thinning of egg shells, weakening of newly-hatched birds, or malfunctions. And when we lose the birds, the predatory insects, and these other insectivores, we *really* get an explosion of insect life--not just in the citrus grove--but in the whole neighborhood."

"But this is the only stuff that works fast enough, and hits hard enough, to do the job," the farmer explained. "When those bugs hatch, we are in trouble right away. I sure don't want to bother those birds, or those other critters either--but dang--my livelihood depends on this fruit being top quality. If I don't spray, my kids don't eat."

Hold a class discussion on these questions:

1. What can these men do to solve their problem? What are their choices? Does either have alternatives available he has not expressed? If so, what are they?

2. How would you resolve this dilemma? What information do you need before making your decision? On what criteria would you base your judgment? What legal constraints and procedures must be considered?

3. Is there something about the quality of oranges that we could perhaps deal with? Would this be a help?

In their search for alternatives and solid criteria, encourage your students to consult the references cited under "Resources" below.

Variation:

After students are familiar with the situation described, divide your class into three groups: the first will advocate the use of DDT; the second will oppose its use; the third will represent the United States Environmental Protection Agency.

The first two groups will research and prepare testimony to be heard by the EPA panel. The panel will decide if the situation warrants issuing an emergency permit for the use of DDT, in accordance with the 1972 regulations banning the chemical.

Students preparing for the "hearing" should consider:

1. The economic implications and long-range environmental impact of granting or not granting the permit.

2. Alternatives or compromise solutions to the problem.

3. The EPA criteria which must be met before the use permit can be approved. (Students role-playing the EPA should research and establish these.)

Resources:

Special note on sources and dialogue: While the above dialogue represents a hypothetical situation, the data regarding the effects reflect the results of actual research. For a review of actual case histories see:

Rudd, Robert L., *Pesticides and the Living Landscape*, (Madison, Wisconsin: University of Wisconsin Press, 1966), pp. 106-109.

The original research was reported by:

Crowter, R. A. and E. H. Vernon, "Effects of Black-Headed Budworm Control on Salmon and Trout in British Columbia," *Canadian Fish Culture*, No. 24:23-40 (1959).

Keenleyside, M. H., "Effects of Spruce Budworm Control on Salmon and Other Fishes in New Brunswick," *Canadian Fish Culture*, No. 24:17-21 (1959).

Kerwill, C. J., "Effects of DDT Spraying in New Brunswick on Future Runs of Adult Salmon," *Atlantic Advocate*, Vol. 48, No. 8, p. 65-68 (1958).

Moreover, because of the considerable quantity of popular literature available on the effects of DDT (most of it less than objective in its presentation), only a highly selected list is given. Further information is extensively referenced in these documents:

Articles — Edwards, J. G., "One Step Beyond: An Inquiry Into Research on DDT." Available from the Terra Society, P.O. Box 110, Mt. Prospect, Illinois.

Hinckley, A. D., "The Gypsy Moth, " *Environment*, Vol. 14, No. 2 (March 1972), p. 41-47.

McCaull, Julian, "Questions for an Old Friend," *Environment*, Vol. 13, No. 6 (July/August 1971), p. 2-9.

McIntire, Greg, "Spoil by Success," *Environment*, Vol. 14, No. 6 (July/August 1972), p. 14-29.

Pamphlets — U.S. Forest Service, "Major Outbreaks of Douglas Fir Tussock Moth in Oregon and California," (Portland, Oregon: Pacific Northwest Forest and Range Experiment Station, 1973) General Technical Report PNW-5.

U.S. Forest Service, "Surveillance Report 1965 Burns Project Douglas Fir Tussock Moth Control," (Washington, D.C.: G.P.O., 1968), S/N 994-184.

Biological Sciences Curriculum Study, *Pesticides (Student Resource Book VI in the Investigating Your Environment Program)*, 1975. Available from Addison-Wesley Publishing Company, South Street, Reading, Massachusetts 01867 (Code No. 0938).

Simulation/Games — The Tussock Moth Issue--available from Georgia-Pacific Corporation, 900 S.W. Fifth, Portland, Oregon. Prepared by the Portland Metropolitan Environmental Education Council.

(Concepts 5A, 5B, 5C, 5D, 5E, 5H) (Junior High, High School)

F. OUTDOOR SURVEY

Have students conduct a survey of families in the school area. Find out how many are: bird watchers, have bird baths, bird feeders. How many are hunters, fishermen, wildlife photographers, bird banders,

etc. Make forms with predetermined questions. Other questions might be: professionally or amateur, how much time do you devote to this hobby? Add whatever other questions you would like the answers to.

Have the class write up a summarization of the report. Use graphs and charts. Write up the results as a newspaper article. Write it up as a radio news item. What effect do these people have on their environment? What effect do they have on wildlife populations? What does their interest indicate about the values of wildlife?
(Concepts 5F, 5G, 5H) (Junior High, High School)

G. THE WILDLIFE MANAGER

Find out what the wildlife person in your state is called--Conservation Officer, Warden, Ranger, Wildlife Manager, etc.

Does this sound like an interesting profession? Find out what he really does, and find out what he has to know. Does he need a college education? What must he study?
(Concepts 1G, 4A, 4D, 4E) (Intermediate, Junior High, High School)

H. COMMUNITY SERVICES IN NATURE CITY

Here is a list of "services" found in nature:

A tick-bird warns a rhinoceros.
A river cleans itself.
A "cleaning fish" cleans other fish.
Bees collect nectar and make honey.
Wasps gather mud and make nests.
Other wasps manufacture paper.
The sun helps plants grow.
Lichens break down rock.
A bear protects his territory.
The wind spreads seeds.
Burrs stick to animals' fur.
Vultures eat dead animals.
Squirrels store nuts.
Birds clean feathers.
Ants take care of aphids which make food.
A woodpecker builds a nest which is used by an owl.

Can you match these up with services found in your community? Such as:

Power company
Garbage collection
Recycling plant
Sewage disposal
Dairy
Home construction
Police protection
Beauty parlor
Airline
Bank
Laundry
Farmer

Can you name other services found in your community? Can you match "services" in nature to all of them? Can you discover "services" in nature that are not found in your community?
(Concepts 2A, 2C, 2D, 2E) (Intermediate, Junior High)

SCIENCE

A. WHY DOES IT LIVE HERE?

Divide the class into groups. Assign each group one of the *biotic communities* of your state: Southwestern Desertscrub, Great Basin Desertscrub, Desert Grassland, Plains Grassland, Mountain Grassland, Chaparral, Evergreen Woodland, Deciduous Woodland, Coniferous Forest, Alpine Tundra, etc.

Each group is to demonstrate, with maps, charts, and graphs, why this community exists where it does, and what distinguishes it from other communities. Maps, charts, and graphs may show: geographic features; vegetation; rainfall; area covered by community; growing seasons; altitude; highest, lowest, and mean temperatures. List species of wildlife native to the area. (Wildlife includes birds, insects, mammals, reptiles, amphibians.)

Reports should attempt to answer these questions:

1. What wildlife species are found in this community?
2. How is the wildlife of the community influenced by the vegetative complex?
3. How does rainfall affect wildlife?
4. Which community has been most affected by modern man? Least?
5. Which community appears to have the greatest variety of wildlife? The most varieties of plants?
6. Define a desert. Does any community clearly fit your description?
7. Are there species which occur in more than one community? In all communities? Which ones?

(Concepts 1A, 1B) (Intermediate, Junior High, High School)

B. HOW MANY CALORIES IN A DEER?

Students should use cookbooks or other resources to find the caloric (energy) values per gram of various meats. Deer meat is usually lean and may be compared to lean beef, if it is not specifically mentioned in resource materials.

Students will compute the number of grams of deer meat needed to obtain one calorie of energy, and make a bar graph illustrating this information. (Caloric values may also be determined by experiments, as described in many science textbooks and laboratory manuals.)

Compare cost per calorie, again using beef as a cost reference as deer probably cannot be legally sold in your state. Depict this information on a graph.

In 1976, there were 13,391 deer harvested in Arizona by hunters. If the average deer weighed 107 pounds (dressed weight), how many calories were available to Arizona households? Using beef as a price equivalent, how much was this deer meat worth?

Hold a class discussion on these questions:

1. What is the relationship between cost and energy values? How would this compare to vegetable foods?

2. What is the relationship between cost per gram and grams per calorie? Graph.

3. Is plant or animal food higher in energy per gram?

4. What other wild animals appear on dining tables? Investigate quantities and subject them to the same processes you have just done with deer meat. (Resource--your state's game and fish department annual harvest data.)

5. Is this wildlife a valuable food resource?

6. How else does wildlife serve as a usable, renewable resource?

(Concepts 4A, 4C, 4D, 4E) (Intermediate, Junior High, High School)

C. RARE, ENDANGERED OR THREATENED WILDLIFE SPECIES

Make a listing of species or subspecies which are categorized as in danger of being eliminated from your state. (Your wildlife agency may have such a list--or use the Federal Endangered Species List.) List your species under: mammals, birds, fishes, reptiles, amphibians, invertebrates, etc.

Ask each student to select a species from the list and gather information about its problems. Reports should include this information:

1. Past and present range of species.

2. Past and present population data, as available.

3. Length of time it has been endangered.

4. Reasons for being on the list.

5. Actions currently being taken to improve its chances of survival. Do you think these actions will be successful?

6. A list of agencies, interest groups, or others who are working on the problem. Who is contributing money to the effort? How is this money contributed?

7. Activities that individuals, or the class, might undertake to aid the species.

8. Describe ways in which good land management could slow down or prevent such losses.

9. Why is it important that this species survive?

10. What is the primary problem of all of the species investigated--is there a one-word answer?

Variation: (Or follow-up activity)

Have students design a hypothetical animal with characteristics which would favor extinction. How do the traits of this species compare with those of any real animals? Now design a species that is highly resistant to extinction.

D. ANIMAL SOUNDS

Tape an assortment of animal sounds, leaving out any identification. Try to pick sounds you do not think students will readily identify. Try some of the owl calls (but not the Great Horned owl), elk, frogs and toads, strange birds such as Coppery-tailed Trogons and the Prairie chicken.

Play these sounds for the students--don't comment on what the sounds are, just let the students listen. Then tell them that each sound is made by an animal and let them hear the sounds again.

Have each student design an animal to fit one of the sounds. Allow them to choose a sound that appeals to them and draw an animal to fit it. These animals can be realistic or purely imaginary. Allow the tape to keep playing as the students make their drawings.

When all drawings are complete, play the tape and identify each animal. Have students match drawings to sounds.

Records:

Records of animal sounds such as:

Voices of the Night, Houghton-Mifflin; The Swamp in June, Droll Yankees, Pomfret, Vermont; and A Field Guide to Western Bird Songs, Peterson series, sold by Audubon are available for purchase from record stores or by loan from large libraries.

(Concepts 1A, 1B) (Primary, Intermediate, Junior High, High School)

E. CAMPUS SAFARI

Take students on a "pretend safari" around your campus, in the neighborhood, or to a park. Pretend that buildings are great boulders or mountains. Search the nooks and crannies for living things. Many of them are very small, so search carefully.

Is the shrubbery similar to a forest understory? What signs of life can be found here? Look on the undersides of leaves and on twigs and stems.

Are the trees a little like a forest? Will you find different kinds of life here?

Look for these living creatures or their signs. Use hand lenses to see them better. Make drawings of what you see. These things you see are also "wildlife"--insects and other small creatures live under the same rules of nature as bears, deer, or robins. Learning about these more-easily found animals leads to a better understanding of all animal life--including man.

NOTE: Bring back only memories, your notes or drawings, and photographs--leave only your footprints. This is good training for later visits to wildernesses and great natural wonders in the out-of-doors. Remember, other classes might like to have the same adventure as you have had, and find the same wonderful things you have found.
(Concepts 1A, 1B, 1D) (Primary, Intermediate, Junior High)

F. MEASURE A STREAM

1. Mark off 100 feet of a stream. Use an average area.

2. Using a stopwatch, measure how long it takes a small twig to go from one marker to the other.

3. Measure the width of the stream at three points. Divide to find average width.

4. Measure the stream depth at each of these three widths. Measure 1/4, 1/2 and 3/4 of the way across. Average the nine depths.

5. To find the cubic feet of water per second:
average width x average depth x feet per second = cubic feet of water per second.

Water flowing at one cubic foot per second = 448.83 gal. per min.
One cubic foot of water = 7.48 gals.
One cubic foot of water = 62.40 lbs.

To find how many gallons of water per minute are flowing in a stream per second: Stream flow in cubic feet per second x gallons in one cubic foot of H_2O = gallons of water per second.

How many gallons per minute, per hour, per day, per year?

How much water does your community use daily? How much per person? (Information available from your city water department.)

How many people could your stream supply with water? (Gallons of water per minute x number of minutes per day = gallons of water per day divided by the amount used per person = total number of people who could be supplied by the steam.)

If a 12-inch trout needs 1000 cubic feet of water for his environment, how many 12-inch trout could live in one mile of this stream?
(Concepts 1A, 1D) (Intermediate, Junior High)

G. FOOD WEB GAME

This game demonstrates the interdependencies that exist among all living things, including man, and between living things and the non-living parts of their environment. The game shows that all life depends on soil, water, air and sunlight; that predation is a part of life and that man can affect other forms of life by his management, or mismanagement of soil, plant life and wildlife.

Materials needed: A large ball of string or colored yarn, signs with strings attached so that they may be worn around the neck, for each student. On these signs, letter and/or draw such things as: sun, air, water, soil, several plants (grass, shrubs, trees), several herbivores (insects, birds, mammals), several carnivores (insects, birds, mammals, reptiles). You might add some of man's plants and animals. Make one sign for each student (see item J under "Art").

Seat the class in a circle and distribute the signs. Use an inquiry technique here--"Where does all of the energy for life come from?" "The sun--right." "All right, here's a bright looking student." Place the sun sign around his or her neck. Continue on with a questioning technique until all signs are distributed. As the teacher, you know your children and can have a lot of fun while stirring up interest with this technique of distribution.

Now, with the ball of string, again start your questioning—"Where did the energy come from?" Give the "Sun" the end of the string and continue questioning until the string has been stretched to every element of your ecosystem.

When the "Web" is completed, discuss the concept that everything here is tied to everything else, and that wherever the string is plucked, it vibrates throughout the web. Whatever happens in one area of this little ecosystem is felt in all areas. If a fire burns the plant life --or a drought kills all the plants--what does it affect? What is not affected?
(Concepts 1A, 1B, 1D, 2A, 2B, 2E) (Primary, Intermediate)

H. CLASSIFICATION

On a field trip to a pond, stream, meadow, forest or desert, children can learn to develop a classification system that will be meaningful to them. One simple system can be based on size alone. After choosing an item (a rock, a plant, an aquatic insect--whatever) that is a "typical" size for each of three categories (small, medium, large), the pupils can decide into which group others of the same species best fit.

Abundance might be another basis for classification. Children can classify by color, size, abundance, feel, smell--any way that can be recorded.

If such things as aquatic insects or insects found in the meadow are used, children will soon realize that smaller animals are much more numerous than large. How about microscopic creatures? Pond water

usually contains fantastic amounts and varieties of life. Can the children count living organisms in drops of water? Can they classify using just descriptions of these organisms? (17 long, skinny, wiggly ones--11 short, fat ones). Soil organisms are also numerous.

Questions that may arise from observing, classifying and recording are:

1. In what part of the pond are most animals found?

2. How might a day sample vary from a night sample?

3. Which animal is most numerous in the samples?

4. Are there more living things <u>in</u> the pond or meadow, or <u>around it</u>?

5. What will some of these pond creatures become? (Many are larval stages of insects, mosquitoes, caddis flies, mayflies, etc.)

(Concepts 2A, 2B, 2C, 3B) (Primary, Intermediate)

INDUSTRIAL ARTS

A. DESIGN A DEN

Have students design dens for various species of wildlife. Research the animal for specific size, conformation, size of hole it can get through (a cat can get through any hole that it can stick its head through), climatic conditions in the animal's environment, what denning materials does it use and how, locations of dens, exposure. Why does this species den and what are its requirements in its den? What time of year does it den? *Nocturnal* or *diurnal?*

Students could investigate rodent, or other, dens as available. They can take internal and external temperatures, and dig dens out. This should be done carefully so as to be able to see the complete structure.

Have students make scale models of dens from their designs. These could be made from plaster of Paris or papier-mache.

Discuss:

Should man be a "denning animal" in desert or polar regions? How would this affect our energy use? Water consumption? Resource use in building materials?

(Concepts 1A, 1D, 1E, 1F) (Intermediate, Junior High, High School)

B. FOR THE BIRDS

Have students devise and follow through on a plan to mass-produce birdhouses. Design several different models. Consider all problems of materials and equipment needed, logical production procedures, potential rates of production, markets for products, costs, sales prices, profit percentages, and the distribution of profits (could they be donated to the local Audubon Chapter, Sierra Club, or state wildlife agency?).

A birdhouse is not just a box with a hole in it for the bird to get in and out. Some real investigation needs to be made of the following: What bird or birds are we building for? How large should the box be? What size should the entrance holes be? Where will the nest box be placed? How high off the ground? Are some protective devices needed?

Students might do some of this research as a part of a biology class. Certain testing could be done: nest boxes facing different directions, different elevations, and different locations. Which are most acceptable to the species?

Follow up the production with a total marketing process--advertising, bookkeeping, tax considerations, etc.

A second project could be to design and make bird feeders.

(Concepts 1A, 1D) (Junior High, High School)

C. INSULATION IS FOR THE BEARS

Material	Percent Efficiency
Wood	100.0
Stone	6.4
Cinder Block	22.4
Common Brick	16.0
Aluminum	.06
Air Space*	77.6

*Air space 3/4 to 4 inches in thickness

Using the table provided, ask students to calculate the answers to these questions:

1. How many times more efficient is wood than stone as insulation?

2. How many inches of stone would be required to insulate as well as two inches of wood?

3. Is a woodpecker's nest in the heart of a 10-inch diameter tree better insulated than a bear den inside three-foot thick rocks?

4. How thick would the walls of the bear den have to be to be better insulated than the woodpecker nest?

5. Design an experiment to determine the insulation value of soil vs. wood or stone.

6. How deep would a rodent den need to be to reduce a ground surface temperature of 100° to 85°?

7. Design an experiment to test the insulation value of a saguaro cactus vs. wood, stone, or earth. (To design the experiment, you need to read a little about saguaro cacti.)

8. Is the retention of heat important in the insulation of a nest or den?

9. Compare these efficiencies with the materials in your home.

(Concepts 1A, 1C, 1D) (Intermediate, Junior High, High School)

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Milne, Lorus J. and Milne, Margery. The Ages of Life. Harcourt, Brace and World, 1968. What is growth and how does age affect it? The detailed patterns in living things. Excitingly told by outstanding naturalists.

Milne, Lorus J. and Milne, Margery. Balance of Nature. Knopf, 1960. The interrelationships of all living things, and Nature's attempt to keep them in balance.

Milne, Lorus J. and Milne, Margery. Paths Across the Earth. Harper, 1958. A team of noted naturalists tell the intriguing story of animal migrations, and of the ways in which life spreads over our world.

Milne, Lorus, et al. The Secret Life of Animals: Pioneering Discoveries in Animal Behavior. Dutton, 1975. Fascinating stories of animal behavior.

Milne, Lorus J. and Milne, Margery. Senses of Animals and Men. Atheneum, 1962. The fascinating senses of animals—compared with those of man and what man can learn from the studies of animals.

Milne, Lorus J. and Milne, Margery. The World of Night. Viking, 1956. Fascinating observations of animals that travel by night. What happens under the cover of darkness.

Milotte, Alfred G. The Story of an Alaskan Grizzly Bear. Knopf, 1969. Very well-told story and life history of a grizzly. Authentic and interesting.

Morris, Perey A. An Introduction to the Reptiles and Amphibians of the U.S. Dover, 1974. An informal and fairly thorough description of the habits of these animals. Provides good information for observation and study.

Mowat, Farley. Never Cry Wolf. Dell, 1977. A wildlife biologist spends a summer studying wolves. One of the funniest books you will ever read.

Mowat, Farley. A Whale for the Killing. Penguin, 1973. The true story of a whale, stranded in a deep cove, and what happened to him.

Murie, Adoph. A Naturalist in Alaska. Devin-Adair, 1961. Living with and studying wolves, grizzly bears, and other animals in Alaska.

Murie, Margaret. Wapiti Wilderness. Knopf, 1966. The Wyoming adventures of a wildlife biologist studying elk.

Murie, Olaus Johan. The Elk of North America. Stackpole, 1951. The habits, food preferences, migration—almost everything a naturalist would want to know about this great deer. Written by a great field naturalist.

Museum of Natural History. Field Studies in Natural History. Articles from Natural History Journal of the American Museum of Natural History. Foreword by Marston Bates. New York: Van Nostrand Reinhold Co., 1970.

National Audubon Society, Educational Services, 950 Third Avenue, New York, NY 10022. Produces a series of excellent wildlife materials. These include booklets, charts, teacher and student manuals, workbooks, nature bulletins, teaching aids, posters, slides, etc. The materials are inexpensive and cover not only birds, but mammals, plants, insects, ecology and conservation. Send for their latest catalogue. Audubon Magazine is one of the most beautiful in the world and has excellent articles and stories on wildlife, ecology and conservation. It should be in your libraries.

National Wildlife Federation. The NWF has a number of publications which are excellent. Single copies free, additional copies very inexpensive. Write: National Wildlife Federation, 1412 16th Street, N.W., Washington, DC 20036.

Pesticides and Your Environment. For the home gardener.
Pesticides are Perilous. A reprint from "Ranger Rick" magazine.
Birdwatching. Where to look and how, with checklist.
Wildlife Notes. Five sets of compact discussions of animals and their habitats.
Estuary. The wild creatures that inhabit estuaries.
Wildlife of Farm and Field. Animals common to farms and open fields.
Wildlife of Forest and Rangeland. Common species found in forests, deserts and rangelands.
Wildlife of Lakes, Streams and Marshes. Common animals found in these aquatic habitats.
Endangered Species of the U.S. The problem of extinction and how a citizen can help.
List of Native U.S. Endangered and Threatened Species. Compiled by state, with common and scientific names.
Should we Hunt? A well-reasoned explanation of regulated hunting as a management tool.
Hunting and Conservation. Hunters and conservationists are synonomous.

The National Wildlife Federation also publishes three very excellent and beautiful magazines which should be in your school libraries: "National Wildlife," "International Wildlife," and "Ranger Rick," a children's wildlife magazine.

Niehuis, Charley. Trapping the Silver Beaver. Dodd, Mead, 1966. A true story of two boys hired to trap beaver along the Colorado River, their adventures and misadventures. An award-winning book.

Olin Industries, Conservation Dept., East Alton, IL 62024. An excellent inexpensive series of booklets on wildlife species, conservation and wildlife management. Available for $1.00 each are: The Cottontail Rabbit, Gray and Fox Squirrels, The Ring-Necked Pheasant, The White-Tailed Deer, The Mallard, The Elk, The Ruffed-Grouse. Available for 50¢ is: Game, Gunners & Biology. The following are free for single copies, 15¢ each in quantity: Careers in Wildlife Conservation, Principles of Game Management, For the Young Hunter.

Osteen, Phyllis. Bears Around the World. Coward, McCann, 1966. Very well written, comprehensive introduction to bears.

Pain, Nesta. Grassblade Jungle. State Mutual Bank, 1977. In-depth, natural history and fascinating information on six species: grasshoppers, mantids, bees, cicadas, termites, and scorpions.

Park, Ed. The World of the Otter. Lippincott, 1971. Very good life history. Well illustrated.

Parnall, Peter. Alfalfa Hill: Winter. Doubleday, 1975. The animals of Alfalfa Hill prepare for winter. A rather primary reading on ecology.

Peterson, Roger Tory. The Bird Watcher's Anthology. Bonanza Books, 1957. Eighty-five fascinating short stories about birds, as told by an assortment of birders and scientists.

Peterson, R. F. Silently, by Night. McGraw Hill, 1964. Narrative, personal anecdote and scientific study, interestingly told. Filled with facts about bats around the world.

Pond, Alonzo W. Survival in Sun and Sand. Norton, 1969. An interesting study of deserts, their ecology and life, water, survival, adaptation, etc.

Porter, George. The World of the Frog and the Toad. Lippincott, 1967. An excellent, well-illustrated introduction to these common animals.

Pringle, Laurence. Wild River. Lippincott, 1972. A beautiful book on the ecology of a river.

Rawlings, Marjorie K. Yearling. Scribner, 1962. The beautiful story of Jody and his fawn and their life in the Florida swamps. A classic.

Ripper, Charles L. Moles and Shrews. Morrow, 1957. Very good presentation of two almost unknown but fascinating animals.

Roberts, Charles G. Red Fox. Houghton-Mifflin, 1972. Fictionalized life history, beautifully told. A little unrealistic and anthropomorphic, but a good tale well told.

Roever, J. M. The Rascally Ringtails. Steck-Vaughn Co., 1970. A very well-done introduction to three species: raccoon, ringtail, and coati. Brief but good life history. Excellent illustrations.

Rorabacher, John A. American Buffalo in Transition. North Star, 1971. A historical and economic survey of the bison in America. What was the resource, what really happened and why, and what is the future.

Rosen, Ellsworth. Spiders are Spinners. Houghton-Mifflin, 1968. Beautiful introduction to spiders. Takes away fear and creates interest. Fine illustrations.

Rosen, Ellsworth. To Be A Bee. Houghton-Mifflin, 1969. Excellent, simple introduction to bees, probably primary use. Beautifully illustrated; should stir interest.

Rue, Leonard L., III. World of the Beaver. Lippincott, 1964. Very good life history. Well illustrated.

Rue, Leonard L., III. World of the Raccoon. Lippincott, 1964. Very good life history. Well illustrated.

Rue, Leonard L., III. World of the Red Fox. Lippincott, 1969. Very good life history. Well illustrated.

Rue, Leonard L., III. World of the White-Tailed Deer. Lippincott, 1962. Very good life history. Well illustrated.

Russell, Franklin. Argen, the Gull. Knopf, 1964. The long and violent life of a Herring gull.

Russell, Helen Ross. City Critters. Mereidith Press, 1969. An interesting depiction of wildlife in large cities—how they have adapted and thrive living with man.

Russell, Helen Ross. Clarion the Killdeer. Hawthorne, 1970. Good narrative life history of an interesting and common bird.

Russell, Franklin. Corvus the Crow. Four Winds Press, 1972. A crippled crow learns the delicate balance between survival and death.

Schaller, George G. Deer and the Tiger: A Study of Wildlife in India. University of Chicago Press, 1967. A biological study of the interrelationships of the deer and tiger in India.

Schaller, George B. Golden Shadows, Flying Hooves. Dell, 1975. The personal story and adventures of a wildlife biologist in Africa. His studies of the lion, leopard, cheetah, wild dog, and hyena on the Serengeti plains.

Schisgall, Oscar. That Remarkable Creature the Snail. Messner, 1970. Simple, well-explained and illustrated introduction to snails.

Schorger, A. W. The Passenger Pigeon: Its Natural History and Extinction. University of Oklahoma Press, 1973. The natural history of the passenger pigeon in North America and what led to its extinction.

Shuttlesworth, Dorothy. Story of Flies. Doubleday, 1970. An excellent look at the diptera and their value to man, as well as their negative aspects. Good illustrations.

Shuttlesworth, Dorothy. All Kinds of Bees. Random House, 1967. Primary introduction to the world of bees. Well done and illustrated.

Silverstein, Alvin and Silverstein, Virginia B. Rats and Mice, Friends and Foes of Man. Lothrop, 1968. Lee and Shepard. An excellent study of animals most despised by man. Shows values of, as well as dangers of. Very interesting. Well illustrated.

Skutch, Alexander F. Life of the Hummingbird. Crown, 1973. Beautifully illustrated and informative reading about a fascinating group of birds.

Smith, Ned. Gone For the Day. Pennsylvania Game Commission, 1971. An artist/naturalist's notes—a diary of the mountains, streams and wildlife of Pennsylvania.

Soule, Gardner. Strange Things Animals Do; How Scientists Probe Their Secrets. Putnam, 1970. Interesting stories of man's study of animals in the field. Up-to-date.

Stefferud, Alfred (ed.). Birds in Our Lives. U.S. Bureau of Sport Fisheries and Wildlife. U.S. Government Printing Office, 1966. Birds as they affect and are affected by people, other birds, and other forms of life and activities.

Storer, John. The Web of Life. Devin, 1972. A simple, elementary book on the fundamentals of ecology. Outstanding book.

Swift, Ernest F. Conservation Saga. National Wildlife Federation, 1967. A history of American conservation, written by one of the great conservationists of this century—a man who was Game Warden, Assistant Director of the U.S. Fish and Wildlife Service and Executive Director of the National Wildlife Federation.

Tingergen, Nikolas. Animal Behavior. Silver, 1965. Beautifully illustrated introduction to the study of wildlife behavior, by one of the world's top animal behaviorists.

Trefethen, James B. An American Crusade for Wildlife. Winchester Press, 1975. The history of the Boone and Crocket Club and its contributions to wildlife conservation.

Trost, Lucille W. A Cycle of Seasons—The Little Brown Bat. Young Scott Books, 1971. Simple, very nicely told year in the life of a bat.

Van Wormer, Joe. The World of the American Elk. Lippincott, 1969. An excellent life history of the wapiti and its future. Beautifully illustrated.

Van Wormer, Joe. The World of the Black Bear. Lippincott, 1966. Excellent life history. Well illustrated.

Van Wormer, Joe. The World of the Bobcat. Lippincott, 1963. Very fine life history. Well illustrated.

Van Wormer, Joe. The World of the Canada Goose. Lippincott, 1968. Very good life history. Well illustrated.

Van Wormer, Joe. The World of the Pronghorn. Lippincott, 1969. Excellent life history. Well illustrated.

Van Wormer, Joe. The World of the Swan. Lippincott, 1972. Fine life history of a beautiful bird. Good illustrations.

Walker, Lewis W. The Book of Owls. Knopf, 1974. This is a delightfully sneaky book. It will teach you a lot about owls before you realize it, because of the pleasing, popular form in which it is presented.

Warbach, Oscar. Mother Nature's Michigan. Hillsdale Educational Publishers, 1976. An informative, colorful look at the environment, ecology and Mother Nature in amusing and brilliantly done cartoons by a wildlife biologist/artist. Worthwhile, even outside of Michigan.

Ward, Lynd. Biggest Bear. Houghton-Mifflin, 1973. A story that needs to be told more often: that wildlife should be wild. Quite elementary.

Watson, Jane W. Whales: Friendly Dolphins and Mighty Giants of the Sea. Western Publishers, 1975. Full of facts and beautifully illustrated.

Wetmore, Alexander. Song and Garden Birds of North America. National Geographic Society, 1964. Habits and habitats for 327 species of birds and how to attract them to home or campus.

White, William, Jr. A Frog is Born. Sterling, 1972. Very good, well-illustrated life history. Intermediate level.

Periodicals:

American Association for Advancement of Science. Science. A technical magazine on general science issues.

American Fisheries Society. Transactions of American Fisheries Society (journal). Technical journal about fish and their environments.

American Institute of Biological Sciences. Bio-Science (magazine). A rather technical magazine dealing with all areas of biological sciences—but excellent material.

American Museum of Natural History. Junior Naturalist (magazine). A children's magazine of general natural history—a good source of material and activities.

American Museum of Natural History. Natural History (magazine). An excellent magazine on natural history.

American Ornithological Union. The Auk (magazine). A magazine specializing in bird information—rather technical.

American Society of Mammologists. Journal of Mammology (journal). The official journal of the Society of Mammologists—rather technical.

Conservation Foundation. C. F. Letter (bulletin). (Free) General bulletin of all areas of conservation and environment.

Cooper Ornithological Society. Condor (magazine). A magazine for the bird specialist—a little technical.

National Audubon Society. Audubon (magazine). A most beautiful magazine dealing with all elements of conservation, ecology, and environment.

National Wildlife Federation, Conservation News. (Free) An excellent weekly news bulletin on conservation, ecology, and environment.

National Wildlife Federation, Conservation Report. (Free) An excellent free source of information on conservation and environment.

National Wildlife Federation, International Wildlife (magazine). A very beautiful and excellent magazine about international wildlife.

National Wildlife Federation, National Wildlife (magazine). A very beautiful and excellent magazine about American wildlife.

National Wildlife Federation, Ranger Rick (magazine). Generally excellent children's magazine on wildlife—a little too anthropomorphic.

Natural History Society, Naturalist (magazine). An excellent magazine on natural history.

Scientific American, Inc, Scientific American (magazine). "The" magazine on general science material—technical.

Sport Fishing Institute, SFI Bulletin (bulletin). (Free) A good news bulletin on fish and their habits.

Wildlife Management Institute, Outdoor News (bulletin). (Free) A general bulletin of conservation and environmental news.

Wildlife Society, The, Journal of Wildlife Management (journal). The official journal of the Wildlife Society—rather technical.

ENVIRONMENTAL EDUCATION TEACHING ACTIVITIES

Unless otherwise noted, the teaching activity publications listed below are available in both microfiche and hard (paper) copy from Educational Document Reproduction Service (EDRS), and may be located in ERIC microfiche collections. Most are also available in printed form from:

Information Reference Center for Science,
Mathematics and Environmental Education
The Ohio State University
1200 Chambers Road, 310
Columbus, Ohio 43212

Exceptions to the above availability statements are noted with individual references. Prices quoted are those of the Information Reference Center (IRC) as of November 1978, and are subject to change.

TEACHING ACTIVITIES

ED 091 172
John H. Wheatley and Herbert L. Coon, One Hundred Teaching Activities in Environmental Education. 1973; 204 pages. IRC price: $4.05.

ED 102 031
John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume II. 1974; 200 pages. IRC price: $4.65.

ED 125 868
John H. Wheatley and Herbert L. Coon, Teaching Activities in Environmental Education, Volume III. 1975; 195 pages. IRC price: $4.00.

ED 130 833
Herbert L. Coon and Michele Y. Alexander, Energy Activities for the Classroom. 1976; 155 pages. IRC price: $4.50.

ED 137 140
Herbert L. Coon and Mary Lynne Bowman, Environmental Education in the Urban Setting: Rationale and Teaching Activities. 1977; 208 pages. IRC price: $4.00.

ED 141 178
Judith M. Schultz and Herbert L. Coon, Population Education Activities for the Classroom, 1977; 196 pages. IRC price: $4.00.

ED 144 826
Robert H. McCabe, J. Terence Kelly, and Doris Lyons, Man and Environment Teaching Alternatives. 1977; 336 pages. IRC price: $6.00

ED 150 026
Herbert L. Coon and Charles L. Price, Water-Related Teaching Activities. 1977; 160 pages. IRC price: $4.00.

ED 152 541
Mary Lynne Bowman and John F. Disinger, Land Use Management Activities for the Classroom. 1977; 269 pages. IRC price: $5.00.

SE 024 956
Mary Lynne Bowman and Herbert L. Coon, Recycling: Activities for the Classroom. 1978; 154 pages. IRC price: $4.50